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RAW MATERIALS TRANSPORTATION COSTS AND THEIR INFLUENCE ON THE USE OF WASTEPAPER AND SCRAP IRON AND STEEL. VOLUME I. TECHNICAL DISCUSSION

RESOURCE PLANNING INSTITUTE

PREPARED FOR
ENVIRONMENTAL PROTECTION AGENCY

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The grant study evaluates the importance of transportation charges for virgin and competing secondary materials in the investment decisions of the steel and papermaking industries. Three major modes of transport are considered - rail, motor carrier, and inland water barge. Transportation charges are evaluated with respect to revenues generated for carriers. Comparisons of differences in charges are made on both a direct and a chemical-equivalent basis. The report provides substantial empirical data on transportation rates, volume of shipments, and origin and destination for the selected materials. Volume II contains the background material.

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Volume I. Technical Discussion

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FOREWORD

Man and his environment must be protected from the adverse effects of pesticides, radiation, noise and other forms of pollution, and the unwise management of solid waste. Efforts to protect the environment require a focus that recognizes the interplay between the components of our physical environment--air, water, and land. The National Environmental Research Centers provide this multidisciplinary focus through programs engaged in

- studies on the effects of environmental contaminants on man and the biosphere, and
- a search for ways to prevent contamination and to recycle valuable resources.

As part of the attempt to recycle valuable resources, this two-volume study evaluates the importance of transportation charges for virgin and competing secondary materials in the investment decisions of the steel and papermaking industries with respect to rail, motor carrier, and water carrier. Volume II contains background material.

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Research Center, Cincinnati

ABSTRACT

The study examines the transportation revenues for virgin and secondary materials in the steel and paper industries, with respect to three major modes of transport - rail, motor carrier and water carrier. The investigation addresses itself to three specific questions: What are the transportation revenues for virgin and secondary materials in these industries? What is the differential for shipping virgin and secondary materials in these industries? What changes, if any, can be made to encourage the increased use of secondary materials in these industries?

The study examines rate differentials of virgin and secondary materials in the perspective of the corporate manager who must select production materials as part of the larger framework of total corporate investment in plant, equipment and natural resources. The study examines the fact that transportation charges, like any charges, do not take place in a vacuum but are affected by a myriad of factors, including shipping volumes, corporate investment decisions, public policy, market conditions and plant locations. In this light, the study examines the transportation charges for paper and steel production materials, both virgin and secondary, and then assesses the significance of these charges in relation to the production costs of final products.

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I. INTRODUCTION

THE PROBLEM DEFINED

The National Solid Waste Disposal Act of 1965, the Resource Recovery Act of 1970, and various policy statements made by the Executive Branch of the Federal Government all affirm the goal of increased recycling of secondary materials. Two basic stimuli account for these and similar acts at the state and local levels: 1) the dwindling supply of virgin raw materials; and 2) the decreasing number of adequate disposal facilities.

A recent study[1] has pointed to the dearth of adequate disposal sites as the more immediate of the two problems for municipal solid waste management. For many municipalities, the sanitary landfill provides a relatively efficient and inexpensive means of coping with a growing solid waste pile. However, for those cities where landfill is an unfeasible solution, the alternative, an incinerator, for example, is quite expensive. Given the high cost of disposal facilities, as well as the reluctance of many state and municipal governing bodies to approve new locations for the facilities, many communities have come to regard resource recovery, in a word, recycling, as the primary means for reducing disposal tonnage and prolonging the life of disposal sites.

In the wake of the environmental movement of the past few years, almost every commodity of daily life, newspapers, tin cans, soda bottles, plastic containers, automobiles, refrigerators has become a target for recycling enthusiasts throughout the country. Despite the cries to "reclaim, recover, reuse,"[2] the increase in the volume of materials actually recycled has been small. Throughout the various levels of the "environmental universe" - from the Federal Environmental Protection Agency to industrial groups, such as the National Center for Resource Recovery, the Institute of Scrap Iron and Steel and the National Association of Secondary Materials Industries, to the general citizenry - the opinion is unanimous: the move to recycle has not stemmed the ever-increasing flow of solid waste.

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[1] Task Force Report: The National League of Cities and the U.S. Conference of Mayors, June, 1973.

[2] A slogan of the National Center for Resource Recovery.

Environmentalists on all these levels suggest an array of factors to account for this lamentable situation:

- difficulty in separating the components of the waste stream;
- lack of initiative on the part of industry to create new markets;
- high costs related to processing materials;
- reluctance of procurement officials, both in the public sector and in private industry, to make the change from virgin products to secondary materials.

As significant as these factors may be in limiting the progress of secondary materials usage, environmentalists, almost without exception, point to transportation of goods from disposal sites to production facilities as a crucial problem in solid waste recovery. These groups have argued, first, that virgin materials travel to production facilities at a significantly lower cost than do their secondary counterparts; that this situation operates to make virgin materials more desirable production inputs and, consequently, inhibits widespread deployment of secondary materials.

Drawing from these contentions, then, this report will examine the following hypothesis:

> Transportation costs for virgin and secondary materials are significantly different, and this difference adversely affects the amount of secondary materials used.

In other words, our problem has become one of documenting transportation costs to determine if, in fact, differences do exist, and if so, how they affect the use of secondary materials. It is also necessary to determine whether or not transportation costs rank as a major proportion of production outlays, as some have argued.

A spokesman for the National Association of Secondary Materials Industries (NASMI) has capsulized the transportation rate issue in a statement before a Congressional Subcommittee: "A significant cost factor in the recovery and utilization of recycled materials is that related to transporting the materials to their natural and most economical market. Through the past years, the transportation rates established by the nation's railroads and steamship conferences and companies have discriminated against recycled materials as compared to their virgin counterparts....In short, transportation rates and policies have not been adequately related to recycling objectives that have been pronounced by the Federal Government as essential to the economic and environmental goals of the nation."[3]

In addition to alleged discriminatory rates, spokesmen for the scrap industry also point to the quality of transportation services as favoring the use of virgin over secondary materials in the production process. Specifically, they cite terminal delays, availability of vehicles, transit delays, and damage claims as key areas of difficulty under this "customer service heading". Herschel Cutler, a member of the Institute of Scrap Iron and Steel, has defined this problem with specific regard to railroad services to scrap iron and steel dealers: "Though it is a regulated industry, the railroads, recognizing the captivity of the scrap shipper, have found it possible to discriminate in both critical areas, rates and services. The scrap shipper, therefore, finds that he is faced with inadequate, poor, and at times non-existent car service as well as rates which fail to reflect the competition existing between ferrous scrap and iron ore. The twofold effect of this transport discrimination yields the condition that iron and steel scrap moves only when the unrealistically high rates can be absorbed by the collection and processing system and only when freight cars are available to move the material after such absorption is undertaken."[4]

If these transportation rate and service biases indeed exist then the recycling of secondary materials may be hindered in favor of their virgin counterparts. But to prove the existence of the transportation problem is not a clearcut task. First of all, the scarcity and quality of statistical data hinders the investigation process. In addition, a definitive determination of the substitutability of virgin and secondary materials is tenuous at best. Finally, an industry-wide standard for comparing virgin and secondary transportation costs does not exist. As an indication of these difficulties, the Interstate Commerce Commission (ICC), the major transportation regulator and the collector of most transportation statistics, has stated emphatically that rate biases for railroads do not exist. In a recent environmental impact statement the ICC concluded: "We [the Commission] have examined the rate structure maintained by the railroads and we do not find the bias that prefers primary [virgin] commodities to the prejudice of secondary materials that is said to exist."[5]

---

[3] Mighdoll, M.J., National Priorities for Recycling: Proposals for a Legislative Action Program, a statement made before the Fiscal Subcommittee of the Joint Economic Committee of Congress, Washington, D.C., November 8,1971

[4] Cutler, Herschel, "Role of Transportation in Disposal of Obsolete Metallic Waste", in Waste Age, (July-August, 1970).

The conflicting positions of the scrap industry and the ICC suggest the high degree of controversy over the relative cost of moving secondary materials and emphasize the need for a thorough investigation of the transportation rate issue.

Determining whether transportation costs discriminate against secondary materials is only one dimension of the problem. Even if a transportation cost differential can be shown to exist, determining how this differential influences the decision to use secondary materials presents another problem entirely. Is it true, for example, that transportation costs represent a large proportion of production costs? Or can it be that they provide only a minimal influence on materials usage decisions? Establishing the true effect of transportation cost differentials requires some insight into an industry's capital decision allocation process, its astuteness in managing transportation costs as well as other intangible factors which determine materials usage. Establishing the impact of freight costs on production decisions as well as proving or disproving the existence of cost differentials, then, are two essential tasks to determining the influence of transportation rates on the usage of secondary materials. These two tasks are the primary concerns of this study.

---

[5] Interstate Commerce Commission, Ex Parte No. 281, Increased Freight Rates and Charges, 1972, Environmental Matters (Washington, D.C., March 5, 1973), p. 188.

PREVIOUS STUDIES

- Interstate Commerce Commission, The Utilization of Waste Material is of Economic Value to the Country - Reduced Rates, 1922.
- T.M. Barnes, Battelle Memorial Institute, The Impact of Railroad Freight Rates on the Recycling of Ferrous Scrap, 1972.
- H.O. Whitten and Associates, Reclamation: Rail Transport Economics of Substitutability of Scrap or Waste for Basic Raw Materials, 1971.
- Interstate Commerce Commission, Increased Freight Rates and Charges - Environmental Matters, 1973.

The cost of transporting secondary materials is neither a new problem nor one which has eluded previous analysis. Records of the ICC show that the problem has been studied since just after the First World War, and even then it was a topic of controversy.[6] With the continuing railroad rate increases over the years, the ICC public hearings have offered a forum for the debate. A look at the studies resulting from this long-term controversy reveals that most advocate a specific pro or con position and do not always provide impartial, unbiased data. Also, most of these studies have concentrated on a single transport mode and/or a single secondary commodity. Though many of these studies are replete with rate statistics, it is important to note that the data-gathering process involved taking small samples which may not always have been representative of the total situation. Then, too, the studies generally contained little information on other transport costs or data detailing how transportation costs influence the use of secondary materials. To complete this review of the present literature on freight rates and their impact, we have extracted the salient features from three of the most recent and most important studies on transportation cost differentials.

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[6] An early example of this controversy is the ICC case entitled: The Utilization of Waste Material is of Economic Value to the Country - Reduced Rates, 1922, 68ICC-676, 720 (1922).

The Institute of Scrap Iron and Steel commissioned the Battelle Memorial Institute to prepare a study subsequently entitled, "The Impact of Railroad Freight Rates on the Recycling of Ferrous Scrap." Essentially, the report gave impetus to ISIS's contention that the railroads favor iron ore shipments over those of scrap iron and steel and contained several important conclusions:

- that if all other factors were equal, freight rates alone would determine the selection of input material;
- that, in a comparison of freight rates for chemically-equivalent amounts of scrap and virgin materials necessary for one ton of steel, virgin inputs moved under lower average rates;
- that a look at return on investment figures for the steel industry indicates that a previously derived rate differential might significantly affect the decision to use scrap rather than virgin materials;
- and finally, that some recyclable scrap is unable to move, and the unnecessary accumulations of solid metallic waste result in despoiling of the environment.[7]

In this study lies the basis for much of the current pressure to hold down railroad rate increases on secondary materials.

At the request of the Council on Environmental Quality, H.O. Whitten and Associates prepared a study for the Department of Transportation (DOT).[8] Though service costs were covered, the report emphasized rate differentials specifically for railroads. A nonlinear curve fit to 1966 ICC one percent Waybill data indicated that iron ore moved at a lower rail rate than scrap iron and steel on a comparable mileage basis. Whitten suggested that the difference could be reduced or eliminated by reducing terminal costs for scrap as well as by increasing the load of cars. The study also emphasized the paucity of available data and the primitive methods employed by many railroads to calculate shipping costs. Available evidence does not show that any of the report's suggestions have been implemented or are under current consideration for implementation.

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[7] Barnes, T.M., The Impact of Railroad Freight Rates on the Recycling of Ferrous Scrap, (Columbus, Ohio: Battelle Columbus Laboratories, 1972).

[8] Whitten, H.O., Recyclamation: Rail Transport Economics of Substitutability of Recycled Scrap or Waste for Basic Raw Materials, Department of Transportation Contract #PS-20608, (Washington, D.C. 1971).

A final example of the recent literature on freight rates is an ICC study entitled, "Increased Freight Rates and Charges." Prepared under the direction of the court to comply with the National Environmental Policy Act (NEPA), this study also focused on railroad rate differences between virgin and secondary materials. Its purpose was to determine the impact of proposed railroad rate increases on the nation's environment and how the new rates would affect the movement of secondary materials. Of note is the Commission's observation regarding the use of available numerical data: "...many persons participating in this proceeding seem to have adopted the position...characterized by some as the "Dwarfing of Soft Variables Syndrome"...: If you can't count it, it doesn't exist. But no absolute or mathematically conclusive method of balancing the environmental, economic and social values involved in a general rail freight rate increase proceeding currently exists. Instead, there are present a wide variety of unquantifiable factors which this Commission must bring to bear in such decision-making matters.... We admit, of course, that readily quantifiable factors are easier to process and hence more likely to be recognized and then reflected in the outcome than those that resist quantification."[9]

From this, one might think that the ICC was moving away from its traditional position toward one more in sympathy with the ISIS and its supporters. However, the Commission concluded that a rate bias does not exist in favor of virgin materials and that the proposed rate increase would not influence the environment. Regarding scrap iron and steel, it continued to insist that this secondary commodity was not a direct substitute and that rate comparisons with ore were inappropriate. The ISIS suggested that certain errors were built into the study and strongly disagreed with the conclusion that scrap iron and ore are not substitutes.[10] This latter point remains a major bone of contention in the controversy between the ICC and the ISIS.

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[9] Interstate Commerce Commission, Ex Parte No. 281, Increased Freight Rates and Charges, 1972, Environmental Matters (Washington, D.C., March 5, 1973), p. 9-10.

Valuable as these three studies may be in the totality of literature on transportation cost differentials, they have not explored all possible dimensions of the problem. By certain shifts in emphasis, then, this study will take a different approach to the issue as outlined in the next section.

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[10] The Institute of Scrap Iron and Steel, Before the Interstate Commerce Commission, Ex Parte No. 281, Increased Freight Rates and Charges, 1972, Comments in Opposition to Interstate Commerce Commission, Draft Environmental Impact Statement, April, 1973.

OBJECTIVES

This study will attempt to answer three basic questions which other investigations have not fully explored:

- what are the transportation revenues for virgin and secondary raw materials in the steel and paper industries?
- what is the cost differential for shipping virgin and secondary materials in these two industries?
- what changes, if any, can be made to encourage the increased use of secondary materials in these industries?

We have directed these questions toward the ferrous and wastepaper sectors for two basic reasons. First of all, ferrous scrap and secondary wastepaper enjoy relatively strong markets; their transportation costs greatly concern the market's participants. Second, there was a greater availability of data for these two commodities than there was for others.

Each of the three questions can be divided further into several more points for investigation. The first question, then, might be broken down this way:

- what proportion of virgin and secondary raw materials are currently moved by each transportation mode?
- what are the major movements for the materials and what are the spatial relationships among suppliers, distributors and shippers?
- what are the current transportation rates for shipping the materials by the various transportation modes?
- what transportation costs other than rate costs do shippers incur in the movement of materials?

From these inquiries, we can draw an empirical data base for the analysis required in the second and third basic questions. However, in order to answer the second question, that of cost differential, the following further points must be explored:

- what amounts of virgin and secondary material are comparable considering production needs?
- what routes provide a good basis for cost comparisons?
- what rate or revenue data offer the best information for determining cost differential?
- what mode of transportation is the least expensive means of moving raw materials, and within what mode, which type of material, virgin or secondary, moves at a lower rate?

If all other production cost factors were equal, a transportation cost differential could well be the factor determining whether a virgin or secondary material would be used in the production process. Thus, the comparisons called for here should suggest a possible method for making transportation cost comparisons between virgin and secondary materials and the magnitudes of the cost differentials.

The third question follows from the first two and is an attempt to determine both the desirability and the feasibility of changing transportation costs to encourage greater use of secondary materials in the paper and steel industries. This inquiry, in turn, raises the following questions:

- what is the significance of transportation costs in encouraging the use of secondary materials?
- is there a threshold level of transportation cost differential between virgin and secondary materials that will affect the use of secondary materials?

- if a rate differential will influence the use of secondary materials, what is the most appropriate strategy to establish that differential?

The answers to these questions should offer a basis for establishing a transportation policy which is compatible with the national goals of increasing recycling of secondary materials.

II. SUMMARY

The purpose of this chapter is to present an abstract of the information contained in the report. Naturally, the complete documentation and evidence for each point cannot be presented. Instead, the basic points are outlined. This chapter will present a general preview without requiring examination of the more significant level of detail which follows.

Methodology

The procedure used during the study included a descriptive framework where the characteristics of the steel and paper industry were identified particularly in regard to the shipment of virgin and secondary materials. An analytical model was used to establish the basis for comparing the transportation costs of virgin and secondary materials. These costs were compared on a direct basis and on a chemically-adjusted basis. In addition, the transportation costs were compared to the total production costs of a given product to determine the significance of these costs in the production process.

The collection of data is discussed in terms of the type of information needed for the descriptive and analytical models. The method of acquisition is also explained.

Industry and Institutional Characteristics

This chapter includes a discussion of the production processes in the steel and paper industries in order to determine the economic and technological factors that influence the use of secondary materials. The chapter indicates that the integrated firms, which own raw material sources, production facilities and distribution systems, have the technology and economic commitments to continue the use of virgin materials. Further, production facilities that depend on secondary materials, the non-integrated firms, tend to locate near the source of their materials, the urban areas.

Finally, the role of the Interstate Commerce Commission in rate-setting and regulation is examined indicating that a considerable portion of commodity movement is at a rate negotiated by the shipper and the buyer.

Analysis of Transportation Costs of Raw Materials

Three comparisons were made to determine the influence of transportation costs on the use of secondary materials. The first comparison is of greatest import to the study; the second and third comparisons are less significant.

First, a comparison was made of the difference in transportation cost between virgin and secondary materials on a direct and chemical-equivalent basis. On a direct basis, the virgin products do move, in most cases, at less cost than the secondary materials. On a chemical-equivalent basis, scrap iron and steel move at a lower rate than comparable virgin materials and wastepaper moves at a slightly lower rate than a comparable amount of wood chips. Roundwood moves at a lower average rate than wastepaper.

Second, a comparison was made of transportation costs to production costs to determine the importance of these costs in the investment decision. It appears that these costs are not major components of production costs and further, that transportation costs are frequently negotiated and managed at an acceptable level between shipper and buyer.

Third, a comparison was made to determine the carriers' ability to reduce transportation rates. While the data on the carriers' cost basis for each rate was difficult to acquire, it appears that for railroads in the Official (Eastern) Territory where the greatest movement of scrap iron and steel occurs, secondary steel materials contribute less to fixed costs than do the virgin materials.

Finally, a regression analysis of the steel industry's transportation costs for virgin and secondary materials was made to supply more evidence on the influence of shipping costs on the use of secondary materials. Generally, the statistical significance of the regression was very low indicating that the data was very scattered and there was only a slight indication of correlation. To the extent that trend lines did appear from the regression analysis, the lines show a modest to neutral effect of transportation rates as an influence on the use of secondary materials covered in this study.

Conclusions and Recommendations

The most apparent finding in this study is that, on the average, secondary materials are transported at less cost than their virgin material equivalent on a chemically-adjusted basis. On the direct comparison basis, the virgin commodities are transported at less cost than their secondary material counterpart.

The most important finding in the report, however, is not to overvalue the importance of transportation rates as a determinant in secondary material usage. When all economic and corporate decision factors are equal, certainly a difference in transportation cost will determine commodity selection. The capital intensive steel and paper making industries require significant investments in different processing technologies for specific raw materials and products. This investment in processing technique becomes a most important determinant in commodity selection.

In addition to the fixed investment in a certain processing technology, the corporate decision-maker is faced with a reasonably fixed source of materials supply if the company is vertically integrated. In this situation only a supply shortage and under utilization of plant capacity will result in a search for suitable material substitutes.

In all these corporate considerations, the transportation costs are but one variable in the decision to use secondary material.

The importance of the investment decision-making process compared to transportation rate differentials implies that Federal policy should not focus on transportation rates at this time.

From this study, it appears that transportation rates show no particular discrimination toward any commodity. Further, it appears that transportation costs are not a major factor in determining raw material usage. Thus, if the objective of Federal policy is to increase the use of secondary materials then an adjustment of transportation rates does not appear to be the most effective method of achieving that end.

It does appear that a better understanding of the complex interaction among supplier markets, corporate investment policy, and product markets would provide a more sound basis to determine what type of Federal policy, if any, could be used to stimulate more widespread corporate use of secondary materials.

III. APPROACH AND METHODOLOGY

This chapter describes the processes used for both data-gathering and analysis. Essentially, four major areas of discussion will explain the methodology used in this study:

- descriptive framework;
- analytical model;
- data collection; and a
- critique of the methodology.

DESCRIPTIVE FRAMEWORK

The descriptive framework establishes the basic modes of operation of the paper and steel industries with regard to the use of virgin and secondary materials and their means of transport. This informational framework will be couched in terms of the contemporary situation. Wherever assumptions are necessary to complete the framework , they will be designated as such.

The analytical model for this study has been developed around three characteristic functions operative in the paper and steel industries: the investment decision over type of facility, total transportation costs, and the substitutability of scrap for virgin material. From these characteristics are derived specific industrial actions resulting in the use of either virgin or secondary materials. In general, these decisions result from applying industrial policy rules to the particular conditions that prevail at the moment.

In the context of this study, the three characteristics serve to structure a conceptual model of the role which raw material transportation costs play in determining the use of secondary materials.

Because virgin and secondary materials are generally processed according to different technologies, a key question determining the type of raw material to be used in the paper or steel industries is the investment decision: What type of new plant should be constructed and how large should it be? Built into this question is the issue of raw material accessibility, and, by implication, the issue of costs for transporting these materials. The investment decision comes from the highest levels of the business hierarchy. Thus, top-level management must receive information on transportation costs. If corporate officers, boards of directors and their analysts perceive these transportation costs as significant, they will weigh the options of virgin and secondary materials as part of the investment decision. To carry this one step further, if raw material transportation costs influence the recycling of secondary materials, it generally comes through its role in the investment decision. Once management has made its choice regarding materials, whether virgin or secondary, it will generally not alter the decision, for to do so would be both time-consuming and expensive. In general, a plant built to process virgin or secondary material will continue to process that material until either the plant's engineering life expires or the raw material source for the plant is depleted or transportation costs for the raw material become economically unfeasible. If resource depletion pressures a plant to close because of long hauling distances, the proximity of an alternate material source may make it attractive to convert the plant to the alternate raw material. However, the massive expenditures necessary for such a conversion in effect are a new investment decision.

A second function of the decision-making process concerns the difference in total transportation costs for virgin and secondary materials, rather than only the difference in transportation rates. Though this function defies quantifiable verification, we have assumed it to be a reasonable one. The quality of transportation service can create costs which are noted on balance sheets just as are direct rate changes: a dollar spent on holding inventory because of erratic materials delivery equals a dollar paid directly to a carrier. If virgin and secondary materials can be processed into products which sell for the same price, and if all other production costs are equal, then a differential in total transportation costs can be the determining factor in raw material selection. Implicit in this assumption is that managers base their investment decision on new order demand and the least cost alternative for meeting this demand.

The third decision function concerns the substitutability of ferrous scrap or waste paper for virgin ore or timber. Though this lies implicitly within the first two functions previously discussed, because confusion continues to surround this issue, it must be spelled out explicitly.

Steel requires iron unit inputs which can be derived from two primary sources: scrap or various iron ore concentrates. The ore must be reduced through an intermediate step into hot metal before it is suitable for the steel furnace. At the furnace mouth the hot metal or direct iron ore derivative is in direct competition with scrap; in other words, either can be used, depending on the particular technology of the furnace. Thus management must decide whether to build an ore-processing facility--a blast furnace, coking oven or steel furnace-- or a scrap-processing facility--an electric furnace--and, hence, to use the virgin or secondary raw materials.

In the paper industry the substitutability and, hence, competition between virgin and secondary materials is not as clear-cut. The quality of some wastepaper grades precludes their deployment in producing certain types of paper and board; strength and appearance considerations preclude the use of most wastepaper in making many grades of fine and sanitary paper and board. Virgin pulp is an acceptable input for all grades of paper and board, but the use of wastepaper is limited in the production of only certain types of paper and board. Thus, a mill presently using wastepaper as the primary input could replace or supplement its scrap input with virgin material, but a mill using virgin materials as its primary input cannot necessarily supplement or replace this with secondary fibers. In general, combination paperboard presently represents the product area where virgin and secondary materials have the greatest degree of substitutability. A company contemplating a new combination board mill can design it for virgin or secondary inputs or a combination of the two. Such substitution represents the primary investment decision choice between virgin and secondary fibers in the paper industry.

These three generic decision functions form the basis for the analytical model described in the following subsection and will be used to evaluate the data which has been obtained.

THE ANALYTICAL MODEL

In their investment decision, top-level managers opt to build either a plant to process virgin materials or one to process secondary materials into the same product. A crucial determining factor is the comparison of competing costs. Here we assume that if all other costs are equal, the decision will depend on a comparison of transportation costs. The primary element of the model in this study is this comparison. We had hoped to base the comparison on fully quantified total costs. However, the lack of adequate data on many service costs thwarted this objective. Thus, a direct comparison of transportation revenues for virgin and secondary materials was made wherever data was available.

We then made a second and more subjective comparison of service factors which influence the investment decision, in the belief that such a comparison simulates the method decision-makers employ.

We based the transportation cost comparison on both intramodal and intermodal terms. Intramodal, in this context, refers to each mode independently such as rail or trucks and compares type of vehicle and service within that mode. Intermodal refers to comparisons between modes such as rail versus truck. Intramodal indicates any cost biases which may be present in a given mode and intermodal demonstrates the trade-offs available to companies with several alternative means of transportation available to them.

We also made the comparison on a chemically-adjusted basis. This allows a comparison between equivalent proportions of virgin and secondary materials necessary to produce a unit of end product and is the choice a decision-maker faces in obtaining the input components necessary for production.

In addition to the chemically-adjusted comparison, we also made a direct comparison of the principal virgin material and the principal secondary input used in the production process. This comparison may yield valuable information in determining mill siting, since the cost of transporting the principal input can weigh heavily in this decision. In sum, comparison of competing costs should provide a basis for the questions of type of facility to be built and total transportation costs involved in transporting materials.

A second comparison employed in the analytical model concerns transportation costs of the raw materials seen against total production costs or against selling price of the end product. Thus, it should be possible to evaluate the importance of shipping expenses in decision-making. If these expenses figure significantly in the production cost or end price, it is highly probable that these costs will be carefully reviewed when an investment decision is being made. But if the costs contribute a small fraction to production costs or are perceived to do so, then the effect of the costs should be negligible. Though this type of comparison neglects such factors as the ability to manage raw material transport costs and the importance of the traffic manager in the decision hierarchy, it provides an available and relatively simple method for evaluating the importance of transportation costs.

The analytical model employed a third comparison wherever we deemed it appropriate and wherever data was available. This compared revenue which a carrier derived from shipping a particular virgin or secondary commodity with his cost for shipping these commodities and indicates the profit margin under which carriers operate with regard to virgin and secondary materials. Though these margins do not immediately affect the investment decision since they change very slowly, they suggest the amount which shippers might expect to negotiate out of transportation rates. Since low margins may inhibit a shipper from investing in new or better equipment which will upgrade service, a consideration of margin may also provide an index of service quality. In addition, study of shipper's margin may provide a standard for subsidization, should the government feel that rate reductions are an appropriate vehicle to encourage the movement of secondary materials within a viable transportation system.

These three comparisons form the structure of the analytical model in this study and represent the essential elements in the investment decision. The industrial leaders responsible for building new plants must make similar comparisons when arriving at a choice between building a facility to process virgin inputs or building one to process secondary material.

DATA COLLECTION

The information collected for this study was obtained in the context of the comparisons within the analytical model. Whenever possible, information directly applicable to the comparisons was obtained and put into a suitable format. Information which would allow indirect comparisons and general descriptive information on the industries and commodities was also gathered.

Establishing numerical values for the transportation costs used in the direct and chemically-adjusted comparisons is, at best, a very difficult task. Mr. W. Y. Oi, a transportation scholar, has confronted this problem and made the following observations:

> The dependence of an industry on transportation (the degree of substitutability) is an elusive concept defying explicit quantification. The cost of holding inventories, mobility of firms in an industry and ties to raw material sources may provide rough evaluation in some cases. These probes would, it seems, meet with only limited success in any empirical investigation. On the other hand, the importance of transportation costs is an observable variable.
>
> The concept of service simply refers to the quality of transportation. Under the mantle of "service" are included such features as speed, damage to goods, night deliveries, flexibility of schedules and split deliveries. These features or attributes are related to, but not an essential part of the spatial movement of goods. Taken together, they constitute the quality of transportation.
>
> Although shippers generally express a preference for a higher quality of transportation, one usually cannot attach a monetary value to their preference. An improvement in the quality of goods surely enhances its value, yet produce prices and values are constantly changing in response to shifts in demands and supplies as well as to changes in quality. The empirical separation of the quality component of price,

therefore poses an intractable problem.[1]

This study has also faced the issue of non-quantifiable service costs described by Oi, and the decision was made to use the available quantified data on rates and revenue per ton as the primary indicator of transportation costs. The service costs have been treated through a qualitative description of cost differences incurred by virgin and secondary materials. The development of more explicit representations of service costs is beyond the scope of this study.

Quantitative Data

Unfortunately the problem of obtaining transportation cost data does not vanish by limiting transportation cost considerations to direct carriage costs or rates. The data which can be used to establish transportation rates for railroads, motor and inland water carriers are fragmented, dated, overly aggregated and sparse. The type of information available and the quality of the information varies widely among industries and transportation modes.

The following list summarizes the quantitative data which has been collected and used in this study.

- location of virgin and secondary material sources and industrial processing facilities.
- interterritorial movement of raw materials for steel and paper production by mode.
- amount of raw materials carried by three principal modes.
- average revenue and rate data for raw materials by mode.
- amount of raw materials carried per vehicle.
- average haul distance for raw materials by mode.
- chemical equivalents between virgin and secondary materials for producing a unit

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[1] Oi, W.Y. and Hunter, A.P. Jr., Economics of Private Truck Transportation, William C. Brown and Co., 1965.

of final product.

- prices for virgin and secondary raw materials.
- consumption of virgin and secondary raw materials.

The most suitable data for the direct and chemically-adjusted rate comparisons have been found to be average revenue per ton. This information can be found sufficiently aggregated to allow identification of nationwide and regional average rate differentials for railroads and common motor carriers. Unfortunately the average revenue data are not available for private or contract motor carriers, nor for inland water carriers. This void is not, however, a major problem since the private and contract truckers and the inland water carriers do not transport a significant amount of the raw materials.

The comparisons of transportation rate differentials for virgin and secondary materials moving on railroad and common motor carriers were made using average revenue data derived from the ICC's Freight Commodity Statistics (FCS) publications.

Data from the Interstate Commerce Commission's Freight Commodity Statistics for Class I Railroads were gathered for the five year period from 1967 to 1971 (the most recent annual report is that for 1971 published in 1972). Data was compiled for all commodities in each of the three specified railroad districts, Eastern, Southern and Western, as well as the United States. These districts are defined according to the movements of the railroad companies themselves.

The information included in the FCS publication is total number of tons of a commodity being shipped, the total revenues collected by the carrier for each commodity, and the total number of cars of the commodity being shipped during a one year period. From this given data, it was possible to calculate the average revenue collected per ton of commodity shipped, the average number of tons of material per carload, and the average revenue generated per car.

The average revenue per ton was then used as aggregated rate data in the comparisons described above. The average revenues per car and the average number of tons per car were used to compare the loading characteristics of the various virgin or secondary commodities.

A distinct disadvantage of the FCS publication is that it does not indicate differences in average shipping distance or direction moved.

However, another source of railroad data, the Department of Transportation's one percent Carload Waybill Sample, does provide supplemental information on the average distances which the commodities moved, but the information is dated, as the latest samples were conducted in 1966 and 1969. The territories defined in the Waybill Sample vary in the 1966 and 1969 reports and do not conform to the FCS territories. It is possible, however, to match those territories which have similar boundaries for purposes of comparison in this study.

It is interesting to compare calculations made from the FCS data with revenue and loading data from the Sample. These comparisons, illustrated in Tables 3-1 and 3-2 (pgs. 25 and 26), reveal that the FCS and Sample data provide a consistent picture, on a national basis, of the commodities' average rates and loading statistics. However, the close correlation of the FCS data and the data from the one percent Sample, shown in Tables 3-1 and 3-2, suggests that the distance data derived from the Sample is representative of any distance differences existing between commodities. The distance data from the one percent Sample has thus been used to explain rate differences. Also the aggregated data does not allow the revenue data to be plotted as a function of distance or weight. Such plots would enable a comparison of the average revenues on an equal distance and an equal weight basis.[2]

Common Motor Carrier Freight Commodity Statistics were compiled for this study for a four year period from 1967 to 1970 (the 1970 report is the most recent as there is generally a two year time lag for these statistics). Motor carrier figures are given for the United States; for the Eastern District and its sub-regions, New England, Middle Atlantic and Central; for the Western District and its sub-regions, Northwestern, Mid-Western, Southwestern, Rocky Mountain, and Pacific; and for the Southern region. Comparable figures for tonnage, revenues and truckloads are provided in Motor Carrier Commodity Statistics as they were in Railroad Commodity Statistics.

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[2] Moshman Associates, Washington, D.C. include such a comparison in their study of rail freight rates.

Table 3-1. COMPARISON OF CARLOAD WAYBILL STATISTICS AND RAILROAD FREIGHT COMMODITY STATISTICS FOR VIRGIN AND SECONDARY STEEL RAW MATERIALS - 1969

Movement	Statistics	Virgin materials								Secondary material	
		Iron ore		Coal		Coke		Pig iron		Scrap iron & steel	
		CWS*	FCS**	CWS	FCS	CWS	FCS	CWS	FCS	CWS	FCS
Nationwide	tons/carload	76.2	77.1	69.0	74.7	45.7	43.8	NA	91.4	54.6	54.7
	$/carload	174	174	189	233	216	237	NA	360	246	239
	$/ton	2.28	2.26	2.74	3.12	4.74	5.29	NA	3.94	4.50	4.37
Eastern - Official	tons/carload	77.6	79.0	78.1	73.1	42.2	42.7	NA	108.4	55.5	56.5
	$/carload	179	447	212	253	174	201	NA	381	231	233
	$/ton	2.30	5.66	2.72	3.46	4.14	4.71	NA	3.51	4.16	4.12
Southern - Southern and Southwestern	tons/carload	79.8	84.0	48.4	77.9	60.0	45.5	NA	67.7	55.8	52.3
	$/carload	169	195	117	190	231	286	NA	213	258	224
	$/ton	2.15	2.32	2.42	2.44	3.85	6.29	NA	3.15	4.61	4.28
Western - Western Trunk Line and Mountain-Pacific	tons/carload	76.2	76.2	80.0	78.5	52.1	54.2	NA	71.7	49.7	51.7
	$/carload	173	98	167	197	260	374	NA	562	206	261
	$/ton	2.19	1.29	2.09	2.51	4.97	6.90	NA	7.84	4.11	5.05

* carload waybill statistics
** freight commodity statistics

Source: Office of Systems Analysis and Information, Department of Transportation, Carload Waybill Statistics 1969, Territorial Distribution, Traffic and Revenue by Commodity Classes, April 1972 and Interstate Commerce Commission, Freight Commodity Statistics, Class I Railroads, 1969.

Table 3-2. COMPARISON OF CARLOAD WAYBILL STATISTICS AND RAILROAD FREIGHT COMMODITY STATISTICS FOR VIRGIN AND SECONDARY PAPERBOARD RAW MATERIALS - 1969

Movement		Virgin material						Secondary material	
		Roundwood		Wood chips & residue		Pulp		Wastepaper	
		CWS*	FCS**	CWS	FCS	CWS	FCS	CWS	FCS
Nationwide	Tons/carload	57.5	56.3	55.1	54.1	58.2	57.5	34.1	33.9
	$/carload	105	105	130	135	663	942	247	251
	$/ton	1.84	1.87	2.36	2.49	11.38	16.38	7.26	7.40
Eastern - Official***	Tons/carload	47	47.2	41.2	41.4	53.7	51.3	31.5	31.9
	$/carload	121	122	168	129	349	1666	206	269
	$/ton	2.56	2.58	4.06	3.11	6.50	32.48	6.52	8.43
Southern - Southern & Southwestern***	Tons/carload	62	57.6	57.7	56.4	58.4	59.3	36.8	37.6
	$/carload	103	96	94	92	373	581	204	234
	$/ton	1.64	1.67	1.62	1.63	6.44	9.80	5.58	6.22
Western - Western Trunk Line & Mountain Pacific***	Tons/carload	41.7	56.1	54.0	53.8	56.1	58.7	33.1	33.7
	$/carload	111	127	163	174	357	928	229	244
	$/ton	2.67	2.26	3.01	3.24	6.30	15.81	6.89	7.24

*Carload waybill statistics

**Freight commodity statistics

*** See Appendix E for definition

Source: Office of Systems Analysis and Information, Department of Transportation Carload Waybill Statistics 1969, Territorial Distribution, Traffic and Revenue by Commodity Classes, April 1972 and Interstate Commerce Commission, Freight Commodity Statistics, Class I Railroads, 1969.

A sample similar to the Carload Waybill Sample was not available for common motor carriers. Data on private and contract motor carrier rates, for wastepaper only, were obtained from a survey conducted over a one week period in the spring of 1973 by the Traffic Committee of the API. The survey covered the origin and destination of wastepaper movements by mode, as well as the cost and size of the movements for several large shippers of wastepaper. The survey is not an exhaustive sampling of the movement of wastepaper, nor is it void of seasonal fluctuation, but it is the only available data on the movement of wastepaper by private and contract truckers. The wastepaper industry's heavy reliance on this mode of transportation makes this information essential to the comparisons of this study.

A survey of inland water carrier rates for all commodities was conducted by interviews with barge and inland water carrier companies. The survey was not all-inclusive, but the companies contacted were those which use the waterways found by the Corps of Engineers data to be the major routes for shipping paper and steel raw materials. In most cases, the rates are representative of all the movements of a given commodity on a given waterway. In some instances, rates are established purely on a negotiated basis and representative data would require a sampling beyond the scope of this study.

Implicit in the use of the FCS aggregated data and the unimodal comparisons are three assumptions which must be delineated in order to place the comparisons in the proper context. First, the unimodal comparison implies that all raw materials are moved to the production site on a single mode. While most mills do not exclusively use a single transportation mode, they often do rely heavily on one mode. This reliance provides a good approximation to unimodal service on an industry-wide basis. Second, it is assumed that the average distances inferred but not given in the aggregated FCS data are representative of new mills built to use virgin or secondary materials. This can be interpreted to mean that most mills are located to optimize proximity to markets and raw materials. Third, it is assumed that the carriers have been loading the commodities by the best available methods. Based on discussions with industry personnel these assumptions are expected to remain valid through the 1970's.

Qualitative Information

- service characteristics of the transportation modes.
- constraints on using the transportation modes.
- institutional constraints on rates and mode usage.
- economic condition of carriers.
- significance of changes in transportation and industry processing technology.
- transportation characteristics of the various commodities.

The manipulation of this information was generally confined to arithmetic calculations and organizing the data into categories. Linear regression analysis was used to obtain the correlation between railroad transportation rate differentials and the use of scrap iron and steel. However, the paucity and quality of data precluded the use of more sophisticated techniques for analysis.

LIMITATIONS OF THE DATA AND METHODOLOGY

The methodology adopted for this study was dictated by resource and data constraints. The study is a relatively simple and straightforward way of looking at the effects which differential transportation costs can have on the use of secondary materials. The comparisons which comprise the model represent the methods which industrial decision-makers employ. Still the comparisons are unidimensional in that they consider only one difference, transportation costs. While this cost is the focus of the study, it must be remembered that it is but one element in a multivariant decision process. The dynamics of this process and the relative weighing of other variables could possibly delegate transportation costs only to a minor role in the totality. If resources would allow and if data could be developed, the multivariant process could be simulated in a much more sophisticated manner to yield greater understanding of the role of transportation costs in determining secondary materials usage. However, the scope of this study precludes such an investigation.

A word of caution must be said about the aggregation of data for use in comparisons. In bringing together the mass of information in this report, it is hoped that evidence can be generated about overall industry behavior. However, aggregated data can often mask a situation. For instance, much of the available data on rates have been generated from average revenue data. While average revenue data allows for an accounting of the relative usage of various rates, it does not show the variance of these rates. In an actual situation, a company faces a very specific set of transportation costs which varies from location to location and by an awareness of this variation the company may well be able to eliminate any transportation cost differential. It is hoped that future investigations will consider a series of case studies which will reflect the operation of this perceived variation.

Any future simulation techniques or case studies adopted in future investigation will no doubt be contingent on a cumulative development of data sources. It is our belief that data source development should follow a more sophisticated multivariant model to act as a guide for further investigations.

IV. INDUSTRY AND INSTITUTIONAL CHARACTERISTICS

This chapter describes several industry and institutional characteristics which are important in understanding how transportation cost differentials for virgin and secondary materials can influence the amount of secondary materials being consumed by the industry. The chapter includes:

- a brief description of how steel and paper are produced;
- the supply networks for virgin and secondary materials in these industries;
- the spatial characteristics of the industries;
- the regional movements of virgin and secondary materials in these industries; and,
- the ICC's role in rate setting and regulation.

This descriptive material provides a background for the analysis in Chapter V.

INDUSTRY CHARACTERISTICS - STEEL

Steel Production

A distinguishing feature of the steel industry is the integration or lack of integration of the facilities. The majority of steel is produced in integrated facilities, that is, those comprised of a blast furnace to produce the hot metal, an open hearth or Basic Oxygen Furnace (BOF) to reduce the hot metal to steel, and a rolling mill to shape the steel into marketable products. These integrated facilities are, in turn, generally operated by vertically integrated companies which own the virgin ore sources. The organizational integration allows for good management control of resources and certain economies of scale. Since the two types of steel furnaces used in the integrated facility are primarily consumers of virgin raw materials, the integrated facility does not represent a strong market for purchased scrap. Furthermore, a company choosing to build an integrated facility has essentially married its virgin raw material source for the life of the facility.

Non-integrated steel mills do not have a blast furnace. Most facilities of this kind employ an electric furnace and use scrap iron and steel as the raw material. Some non-integrated mills, however, use BOF and open hearth furnaces and can use either pig iron or scrap as the raw material. However, pig iron is generally an undesirable input because the hot metal produced in another facility must be cooled, moved to the non-integrated steel furnace and then reheated. This series of operations plus profit for the pig iron producer raises the price of the material and makes it an economically unfeasible input. As a result of this as well as the relatively low capital requirement of electric furnaces, most non-integrated facilities built in recent years have been electric furnaces. These offer the means to an economical, small-scale operation yielding high quality products. Because of the cost and operating advantages the current builder of non-integrated facilities is using the electric furnace and relying on purchased scrap as the primary input material.

This brief description of the steel industry indicates that future changes in consumption of purchased scrap will be highly dependent on the construction of non-integrated electric furnaces. A company which seeks to satisfy its need for new production facilities has the choice of building the electric furnace and using purchased scrap or building the BOF and using virgin raw materials. This choice is made in the industrial boardroom rather than at the purchasing agent or plant manager level. If more secondary materials, that is, purchased scrap, are to be used in the steel industry's production process, then more non-integrated electric furnaces must be built. Transportation cost differentials for virgin and secondary materials will influence the use of secondary materials through its influence on this investment choice between the electric furnace and the integrated BOF facility. Appendix A provides a recent example of how the investment decision was the major determinant in the selection of raw materials.

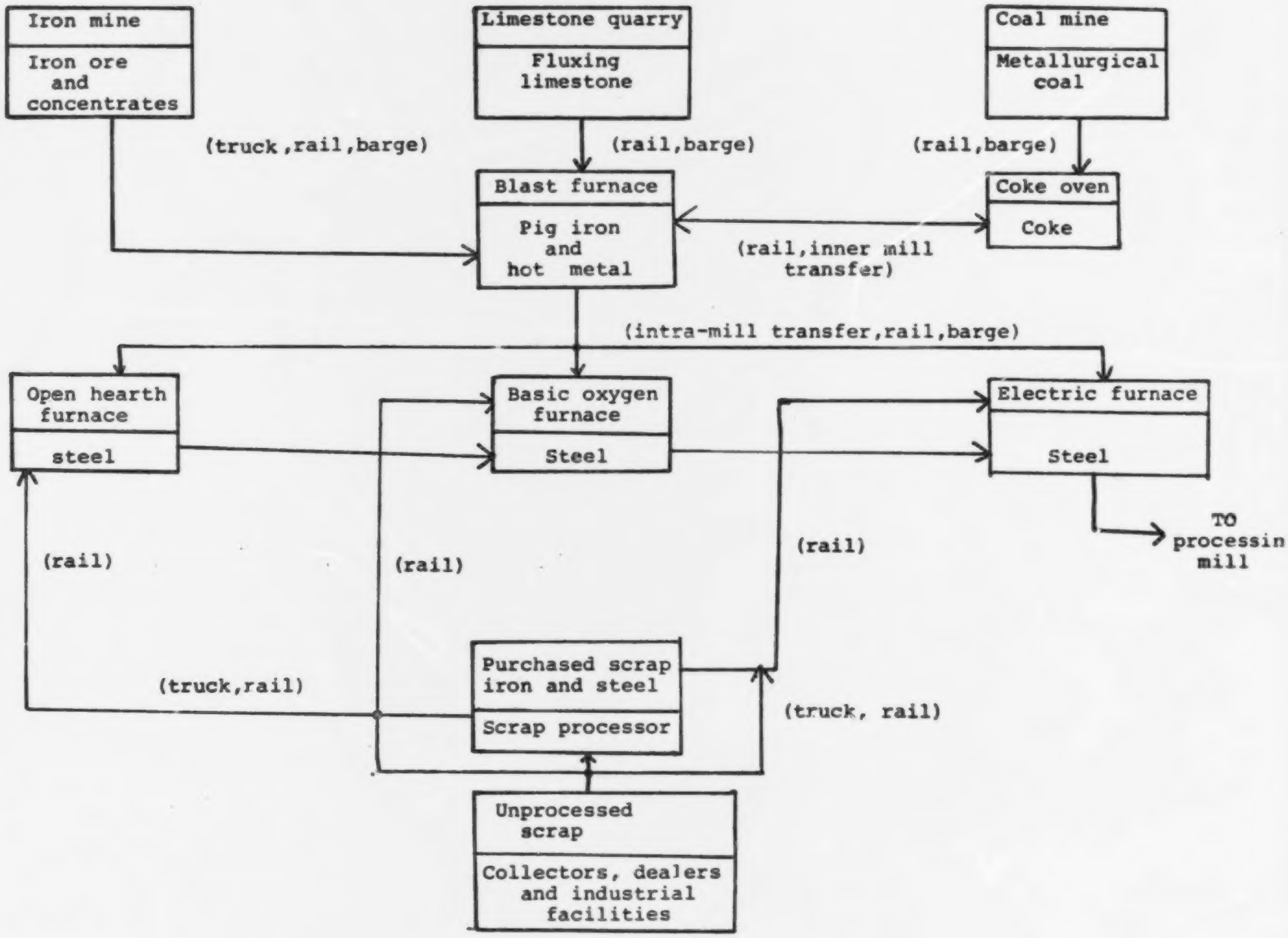
The Source of Raw Materials for Steel Production -

The virgin raw materials for the blast furnace are generally supplied from mines by the companies which own the integrated facilities. Purchased scrap, however, is supplied to the steel furnaces by a network of collectors, dealers, brokers and processors which together comprise the scrap iron and steel industry. As of 1970 there were over 1200 organizations and individuals conducting business in this industry. The collectors are usually one-man operations or charitable organizations who patrol the disposal sites of America in search of obsolete iron and steel products. These agents, in turn, forward their finds to dealers and processors who sort and prepare the scrap for shipment to large processors or directly to the steel mills. The dealers and processors also obtain or broker iron and steel waste from industry, in many cases, from car manufacturers. Scrap obtained from industrial sources is called prompt or industrial scrap. Prompt scrap is particularly valuable because it is generally in a form which allows economical transportation and its composition is known with a reasonable amount of certainty. Often the prompt scrap moves directly from the processing facility to the steel mills; a broker generally acts as the middle-man in this transaction. Often the prompt scrap broker acts as a dealer or processor as well. The scrap which moves through the processor is generally shredded or baled to increase its portability. The development of the shredder has been the major recent technological improvement in the transportation characteristics of scrap iron and steel; the resulting decrease in density allows this commodity to be hauled in heavier loads. The latter point is particularly important to the scrap industry since, in addition to collecting and processing, its members must transport the scrap to the steel mills.

Transportation is an essential function for placing both virgin and secondary raw materials at integrated and non-integrated steel-making facilities. Figure 4-1 (p. 34) illustrates the major movements necessary to transport the raw material to the steel producer. The primary transportation modes currently being used for each movement are shown in parentheses beside the arrow representing the movement. The virgin materials are generally moved by the large integrated companies from the mines to their integrated production facilities. Often these movements are made by transportation modes owned either by the steel companies or by the mine-owners. The movements of virgin material are characterized by large and long-established shipments, bulky commodities, predictable movement and seasonal variations. The steel companies making these movements have a long and enduring relationship with the carriers, and together have established excellent processing facilities to aid in the efficient and economic movement of the materials. Loading, unloading and storage facilities along the transportation pipeline are well established and first rate.

The movement of purchased scrap to the steel mill, generally arranged for by the scrap industry, is made primarily by independent carriers. Scrap iron and steel move in relatively small shipments, a function of intermittent supply and demand; they come from widely distributed sources and are not very predictable. The relationship of the scrap industry and the carriers is highly erratic. Many individual organizations in the industry enjoy excellent working relationships with the carriers; others are less successful in obtaining good transportation services. ISIS, the industry's trade association, has been waging a long and continuous battle against the carriers to obtain what the industry considers equitable freight rates and service. While the loading, unloading and storage facilities for scrap are adequate, they are not on a par with comparable facilities for the virgin counterparts.

Figure 4-1. Transportation Modes Used to Move Raw Materials in the Steel Industry



Iron mine
Iron ore and concentrates
Limestone quarry
Fluxing limestone
Coal mine
Metallurgical coal
(truck,rail,barge)
(rail,barge)
(rail,barge)
Blast furnace
Pig iron and hot metal
Coke oven
Coke
(rail,inner mill transfer)
(intra-mill transfer,rail,barge)
Open hearth furnace
steel
Basic oxygen furnace
Steel
Electric furnace
Steel
TO processin mill
(rail)
(rail)
(rail)
Purchased scrap iron and steel
Scrap processor
(truck,rail)
(truck, rail)
Unprocessed scrap
Collectors, dealers and industrial facilities

( ) indicates principal transportation modes used to move commodities.

Transportation Modes -

The majority of integrated and non-integrated steel producers will only accept raw material shipments by rail. This constraint has resulted from a tradition of locating the mills near railroad facilities to provide safe and convenient loading and unloading. The use of trucks at the mill site has been limited because the loading and unloading of tons of metal by cranes is often off target and this presents damage to the truck and danger to drivers or personnel standing in the area. The heavy reliance on rail movement is demonstrated by the data in Table 4-1 (p. 36).[1] It should be noted that adding the quantitites hauled by all modes in the column headed iron ore gives a sum greater than the indicated consumption. This apparent inconsistency, as will be explained more fully later, results from the two-phased rail and water movement of iron ore and accounts for some double counting of ore shipments in the table. The double counting is also present in the column for scrap iron and steel but to a lesser degree in this column. Scrap often moves to the processor by truck and from the processor to the mill by rail. Dr. Herschel Cutler of ISIS has described the two-mode movement of purchased scrap as follows:

> The railroads have almost been entirely eliminated from the inbound (i.e. to the processor) movement of so-called unprepared scrap because their structure has not recognized "the balloon nature" of the product, a characteristic which does not fit the present rate structure, especially when the very low value of unprepared scrap is considered....The processed material is a much more dense commodity; it comes closer to consuming both the weight and cubic capacity of the vehicles offered for scrap service. 2

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[1] Appendix B shows the amounts of the commodities hauled by rail since 1956 and a more detailed breakdown of inland water carrier traffic by river system.

[2] Cutler, Herschel, "Role of Transportation in Disposal of Obsolete Metallic Waste," Reprint from Waste Age, Institute of Scrap Iron and Steel, Inc., July-August, 1970.

Table 4-1. COMMODITY MOVEMENT BY TRANSPORTATION MODE - 1970
Steel-Making Materials

Transportation mode	Amount of commodity moved (thousands of net tons)					
	Iron ore	Coke	Fluxing limestone	Bituminous coal	Pig iron	Scrap iron and steel
Class I & II railroads	104,208	16,040	NA	395,017*[1]	4,628	28,183
Class I motor carriers	8.9	61.6	NA	268.3[1]	406.4	165.4
Private and other than Class I motor carriers	NA	NA	NA	NA	NA	NA
Domestic water traffic	68,042.4	1,034.2	30,819.4	140,052.7[1]	395	1,505
Total consumpiton of commodity in steel industry	148,063*	59,721	14,265	87,209***	88,780*	29,130**

* production figures
** consumption of purchased scrap iron and steel only
*** consumption of metallurgical coal by steel industry
[1] Movement of all bituminous coal, including metallurgical coal
NA - Not available
Note: The sum of the movements by mode may exceed consumption or production because of two mode movements to transport the commodity to the processing facility or because of alternate uses in other industrial products.
Source: American Iron and Steel Institute, Annual Statistical Report 1970.

The close proximity of coking ovens to blast furnaces is shown by the relatively small proportion of coke moved by the for-hire carriers. Less than 30 percent of the coke is moved by the major transport modes. In addition, less than 7 percent of the pig iron or hot metal is moved by independents. These figures provide an indication of the steel industry's propensity to integrate its facilities when the primary iron source is virgin ore; the coke and hot metal move by intraplant transportation from the coke oven and blast furnaces to BOF or open hearth furnaces.

Data on the amount of fluxing limestone and coking coal moved by the various transportation modes are not available. Discussions with steel companies and industry experts indicate that limestone generally moves short distances by either rail or barge, with about half the total allotted to each mode. Coal for coking ovens is also transported by rail and barge; a reasonable estimate, based on conversations with carriers, would place about 80 percent of the movement on rail.

The apparent heavy reliance of scrap iron and steel on railroads shown in Table 4-1 (p. 36) may be somewhat misleading. A recent news release by the ISIS stated, "Responses [to an ISIS survey] indicated that members shipped an average of 69.8 percent of their tonnage by rail during the first six months of 1971. However, during the corresponding period in 1972, 67 percent was shipped by rail--a 2.8 percent decrease."[3] This observation was made on the basis of the response of about 25 percent of the ISIS members to a questionnarie distributed by the Institute.

The difference between the ISIS survey and Table 4-1 stems from the two-phased movement of scrap. Scrap generally moves into the processor's yard by trucks owned by collectors, dealers and processors and moves out by rail to the steel mill. The ISIS survey, which covered collectors, dealers and processors, undoubtedly included some of the truck movement to the processors.

Unfortunately, there is virtually no data available on the use of private motor transport in this area.

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[3] Fowler, J.E., Institute of Scrap Iron and Steel, NEWS, October 10, 1972.

Discussion with scrap processors held during this study, however, indicates that more than 90 percent of the scrap moving into their yards is by private motor transport. Generally, the truck traffic moves within a radius of 100 miles of the processor.

Table 4-1 illustrates the steel industry's use of the railroads for movement of their virgin and secondary raw materials to the steel mill. The volume of materials and the frequency of use enable the steel companies to secure favorable rates from the railroads. This phenomenon, generally known as the "volume discount" is common in every marketplace. The high usage of the rails by steel companies enables them to manage their transportation costs in contrast to a limited user where his transportation cost will be a given or non-negotiable cost.

Spatial Characteristics -

The location of raw materials sources and consumption points is important for determining comparative shipping routes and cost differentials due to direction, distance, geography and climate. This subsection reviews the locations for mining, production and scrap facilities in the steel industry and how the movement of scrap and virgin materials can differ in terms of direction, distance and geography.

Figure 4-2 (p. 39) and Tables 4-2 (p. 40) and 4-23 (p. 240) show the locations[4] of virgin raw material mines and the blast furnaces where these materials are consumed. Minnesota and Michigan provide the majority of domestic ore while imported ore generally comes in through ports on the East Coast. The majority of the ore must be transported to blast furnaces in either Pennsylvania, Ohio or Indiana. The blast furnace location

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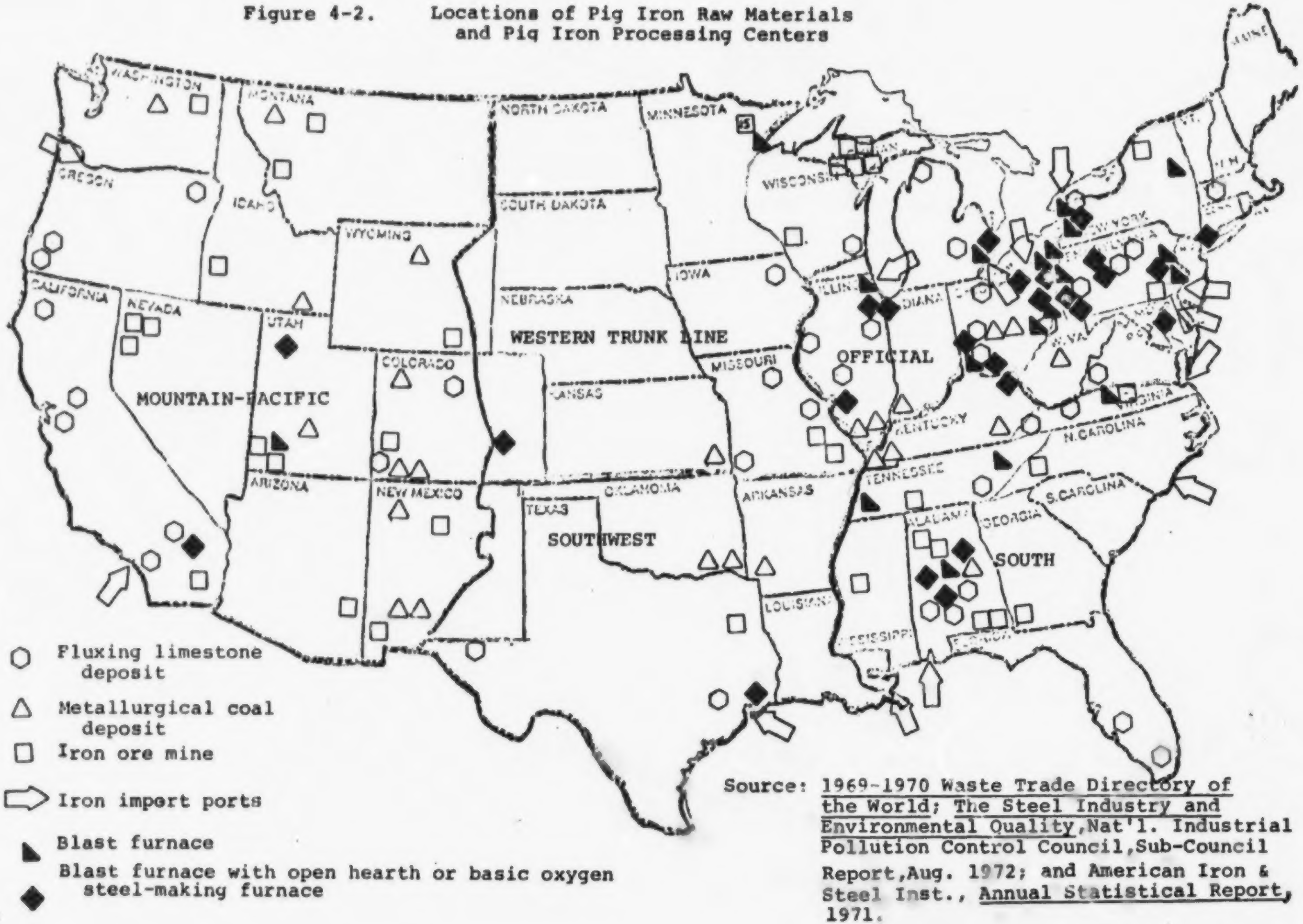
[4] The five regions outlined on this map are the ICC rate-making regions. The regions are the Official Region, the Southern Region, the Western Trunk Line Region, the Southwestern Region and the Mountain Pacific Region. The ICC uses these regions as homogeneous rate-making areas when determining "ex parte" or general rate changes and also establishes many of their statistics on the basis of the regions. Most of the railroad statistics presented in this report will be referenced to these regions.

Figure 4-2. Locations of Pig Iron Raw Materials and Pig Iron Processing Centers


WASHINGTON
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MINNESOTA
OREGON
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NEW YORK
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MAINE
CALIFORNIA
NEVADA
UTAH
NEBRASKA
IOWA
ILLINOIS
INDIANA
WESTERN TRUNK LINE
COLORADO
MISSOURI
OFFICIAL
W.VA.
VIRGINIA
MOUNTAIN-PACIFIC
KANSAS
KENTUCKY
N.CAROLINA
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
TENNESSEE
S.CAROLINA
TEXAS
SOUTHWEST
ALABAMA
GEORGIA
SOUTH
LOUISIANA
MISSISSIPPI
FLORIDA
⬡ Fluxing limestone deposit
△ Metallurgical coal deposit
☐ Iron ore mine
⇨ Iron import ports
◣ Blast furnace
◆ Blast furnace with open hearth or basic oxygen steel-making furnace

Source: 1969-1970 Waste Trade Directory of the World; The Steel Industry and Environmental Quality, Nat'l. Industrial Pollution Control Council, Sub-Council Report, Aug. 1972; and American Iron & Steel Inst., Annual Statistical Report, 1971.

Table 4-2. PERCENT OF U.S. IRON ORE SHIPPED FROM MINES IN STATE - 1971

State	Percent of U.S. total
Alabama	0.6
Arizona	0.01
Michigan	14.1
Minnesota	65.8
Missouri	2.3
Montana	0.01
New York & Pennsylvania	4.0
North Carolina & Georgia	0.3
Utah	2.2
Wisconsin	1.2
Wyoming	2.2
Other:	7.2
California, Nevada, New Mexico, Texas, Colorado, Idaho	

Source: Bureau of Mines, Reprint from the 1971 Bureau of Mines Minerals Yearbook," Iron Ore", Table 5.

represents a compromise among the shipping distances for ore, coking coal and the finished products. For example, one finds blast furnaces around the lower Great Lakes lying near abundant coal resources, large population centers, automobile manufacturers and relatively inexpensive water transportation. The majority of iron ore moves from Minnesota down through the Great Lakes and into the consuming states. This represents the two-phase movement mentioned earlier: rail movement to the Lakes, water movement across the Lakes and rail movement to the blast furnaces. Business Week has described these movements as follows:

> Much of the ore is reduced to iron at Detroit, Chicago and other Lake ports, but a substantial volume moves by rail to such steel centers as Pittsburgh, Wheeling and Youngstown. The fact that ore for these cities has to be shipped from 63 to 145 miles at an added cost would put steel production in these cities at a competitive disadvantage as compared with Lake ports except that this disadvantage is largely offset by nearness to coal deposits. [5]

Other inland and domestic movements of iron ore are relatively localized such as those within Alabama and California. The coal and limestone sources for the blast furnaces are relatively near the furnaces and are comparatively short hauls. The integrated nature of most virgin raw material steel-making facilities and the close proximity of non-integrated steel mills and blast furnaces makes the transfer of hot metal and pig iron a local operation. The relative location of the blast furnaces and the integrated steel mills can be seen by comparing Figures 4-2 (p. 39) and 4-3 (p. 42).

Figures 4-3 and 4-4 (p. 43) and Tables 4-24 (p. 241) and 4-3 (p. 44) indicate the location of major scrap dealer concentrations and scrap consuming areas, steel mills and steel production centers. The proximity of the mills and the scrap dealers suggests the pattern of movement of scrap from processors to the consuming mill. The steel production figures in Table 4-24 (p. 241) reflect the concentration of integrated and non-integrated steel mills in Pennsylvania, Ohio and Indiana. A comparison of Figures 4-3 and 4-4 shows how the non-integrated

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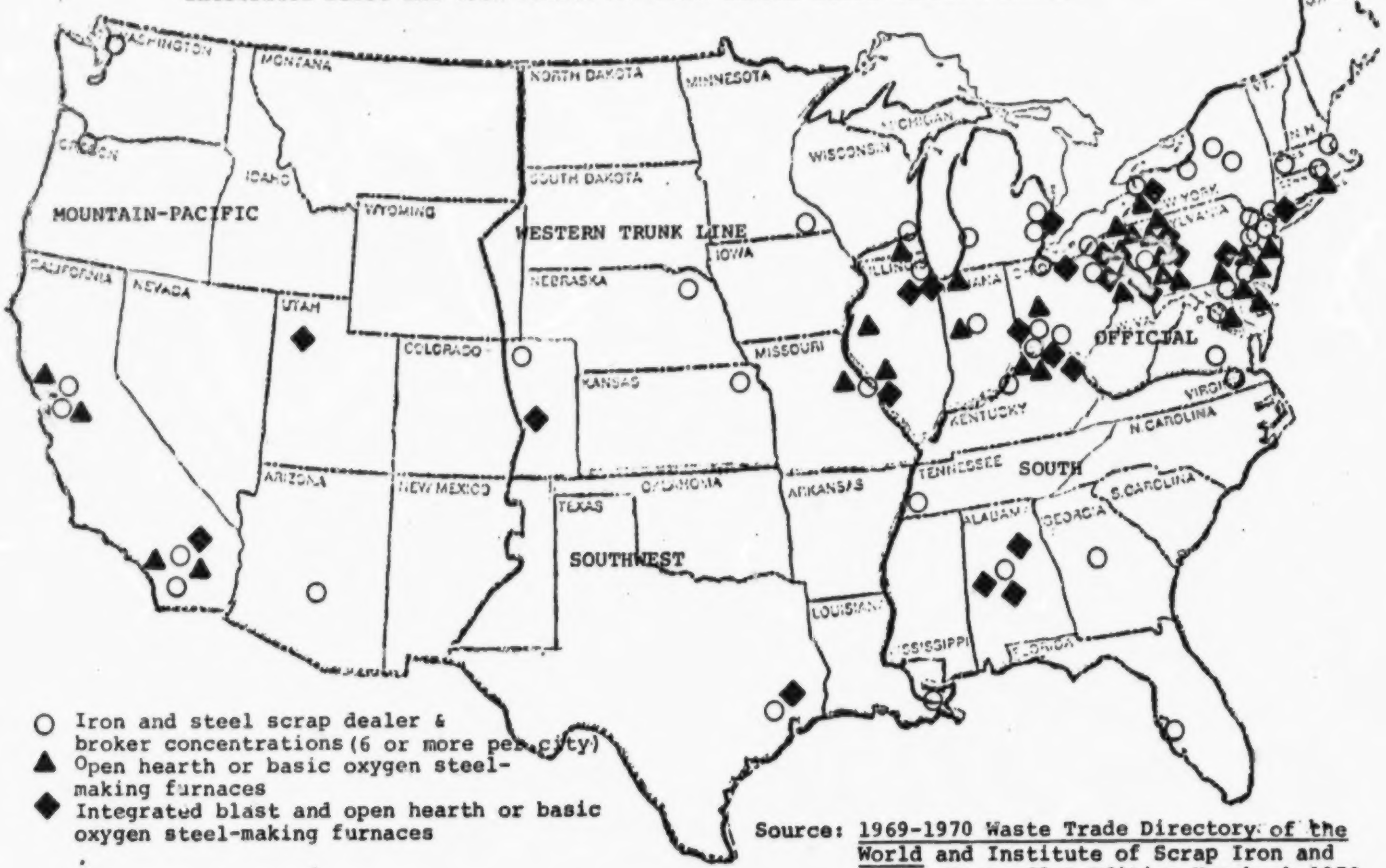
[5] "Freight Rate Hikes Hit a Roadblock," Business Week, January 1, 1972.

Figure 4-3. Locations of Iron and Steel Scrap Dealer and Broker Concentrations, Open Hearth or Basic Oxygen Steel-Making Furnaces and Integrated Blast and Open Hearth or Basic Oxygen Steel-Making Furnaces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CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
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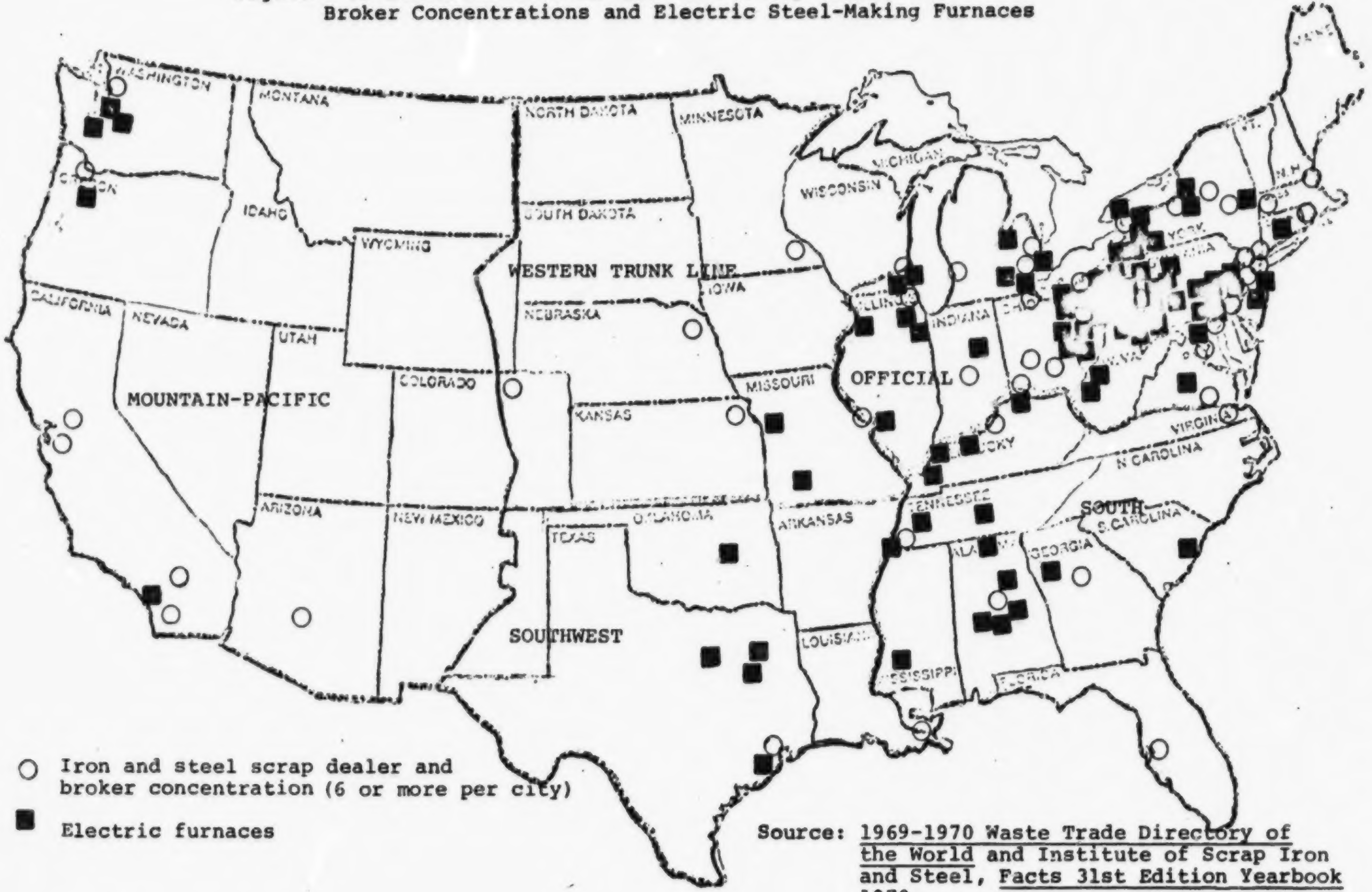
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
WISCONSIN
MICHIGAN
ILLINOIS
INDIANA
OHIO
KENTUCKY
TENNESSEE
MISSISSIPPI
ALABAMA
GEORGIA
FLORIDA
S.CAROLINA
N.CAROLINA
VIRGINIA
W.VA.
PENNSYLVANIA
NEW YORK
VT.
N.H.
MAINE
MOUNTAIN-PACIFIC
WESTERN TRUNK LINE
SOUTHWEST
SOUTH
OFFICIAL
○ Iron and steel scrap dealer & broker concentrations (6 or more per city)
▲ Open hearth or basic oxygen steel-making furnaces
◆ Integrated blast and open hearth or basic oxygen steel-making furnaces

Source: 1969-1970 Waste Trade Directory of the World and Institute of Scrap Iron and Steel, Facts 31st Edition Yearbook 1970.

Figure 4-4. Locations of Iron and Steel Scrap Dealer and Broker Concentrations and Electric Steel-Making Furnaces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ALA
GEORGIA
SOUTHWEST
LOUISIANA
MISSISSIPPI
FLORIDA
MAINE
VT.
N.H.
○ Iron and steel scrap dealer and broker concentration (6 or more per city)
■ Electric furnaces

Source: 1969-1970 Waste Trade Directory of the World and Institute of Scrap Iron and Steel, Facts 31st Edition Yearbook 1970.

Table 4-3. PERCENT OF U.S. PURCHASED SCRAP IRON AND STEEL RECEIVED BY STATE - 1971 (tons)

State	Amount of purchased scrap received	Percent of total
Alabama	1,529,499	4.66
Arizona	W	-
Arkansas	W	-
California	1,306,069	4.00
Colorado	449,718	1.52
Connecticut	62,822	.20
Delaware	W	-
Florida	W	-
Georgia	391,137	1.19
Illinois	4,285,905	13.04
Indiana	1,321,531	4.02
Iowa	407,668	1.24
Kansas	69,906	.21
Kentucky	562,792	1.71
Louisiana	W	-
Maine	W	-
Maryland	271,706	.82
Massachusetts	32,819	.10
Michigan	4,289,700	13.05
Minnesota	220,791	.67
Mississippi	W	-
Missouri	809,479	2.46
Nebraska	W	-
New Hampshire	W	-
New Jersey	452,471	1.38
New York	766,661	2.33
North Carolina	112,453	.34
Ohio	5,354,925	16.30
Oklahoma	264,322	.80
Oregon	132,516	.40
Pennsylvania	4,990,188	15.19
Rhode Island	73,635	.22
South Carolina	24,128	.07
Tennessee	392,260	1.19
Texas	1,721,553	5.24
Utah	28,639	.09
Vermont	7,389	.02
Virginia	211,660	.64
Washington	447,342	1.36
West Virginia	582,113	1.77
Wisconsin	383,895	1.17
Undistributed	896,400	2.60
Total	32,854,092	

W-Withheld to avoid disclosing individual company confidential data; included with "undistributed."

Source: Bureau of Mines

electric furnace mills are dispersed away from the traditional steel belt along the lower Great Lakes. In general, the location of electric furnaces is closely aligned with the population centers with sources of scrap. The figures also show how scrap dealers and processors tend to concentrate in major population centers. Scrap sales figures detailed in Table 4-3 show close association with the location of the electric furnaces in the various states. In general, the flow of scrap from the processors to the mills moves a relatively short distance within major population centers.

Raw Materials Movement -

As has been mentioned previously, railroads and inland water carriers move the majority of steel-making raw materials. This subsection outlines the major movements of raw materials by these transportation modes within recent years. A study of these movements will illustrate one major factor in transportation cost differentials. That factor is the difference in geography, distance, direction and climate associated with regional movements.

The 1969 one percent Waybill Sample data were used to estimate the rail movements.[6] Data on the magnitude of the rail movements were given on a regional basis in the 1969 Sample. Data from the 1966 Sample, on a state-by-state basis, are contained in the Appendix for Chapter IV. The five regions used for ICC rate-making were the basis for the 1969 data. These five regions are outlined on the maps showing 1969 railroad movements.

The relative size of different movements is indicated on maps (see Figure 4-5, p. 47) by various diameter circles (intraregional movement) and various width arrows (interregional movements). A specific table accompanies each map and provides the explicit numerical values associated with the arrows and circles. The data in the tables represents only one percent of all waybills in the two years and does not indicate total interregional and intraregional movements. Though these data were obtained on a relatively random basis, they should provide some indication of the relative differences in movements within and between regions.

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[6] Department of Transportation, Carload Waybill Statistics, One Percent Sample of Terminations in the Year 1969: Territorial Distribution Traffic and Revenue by Commodity Classes (Washington, D.C.), 1972.

The water movements were obtained from 1971 Corps of Engineers data and show total movement of the various commodities by river system for that year. The total amount of the commodity moving up and down the river is shown on maps by arrows and specific numerical values.

As is indicated on the maps, the majority of steelmaking raw materials move within the Great Lakes region. Figure 4-5 shows that iron ore movements by rail are concentrated near the iron mines in Minnesota and Michigan and around the lower Great Lakes region. Some of the ore moves down to the furnaces around the lower Great Lakes by rail, but as is shown in Figure 4-6 (p. 49), a substantial amount moves across the Lakes by water carriers.[7] The ore carried by water is part of the two-phase or two-mode movement where the ore moves by rail to upper ports, by water to lower ports, and by rail to the mills. Since a substantial amount of ore moves via water route and since the Great Lakes freeze in the winter, a seasonability factor must be included in assessing the transportation costs for moving this commodity. This cost would be associated with inventories needed to cover winter production, special equipment necessary for operating in conditions of extreme cold and other abnormal costs associated with cold weather transportation.

In the South, a great deal of iron moves directly to the mills by way of the Black Warrior and Tom Bigbee Rivers. This river traffic consists of ore mines in the Alabama region and also imported ores. In the West, most of the ore moves relatively short distances by rail to the mills either from mines or coastal ports.

The sample average distances of the 1969 iron ore movements, as cited in the Carload Waybill Statistics, are given in Table 4-5 (p. 50). The average shipment of iron ore traveled an average of 237 miles. However, the regional variation around this average equalled plus or minus 60 miles, depending on the region. The Official Region movement from the lower Lake ports to the mills was, on the average, the shortest while the more direct shipments from the mines to the mills in the Southwest and Western Trunk Line Regions were the longest.

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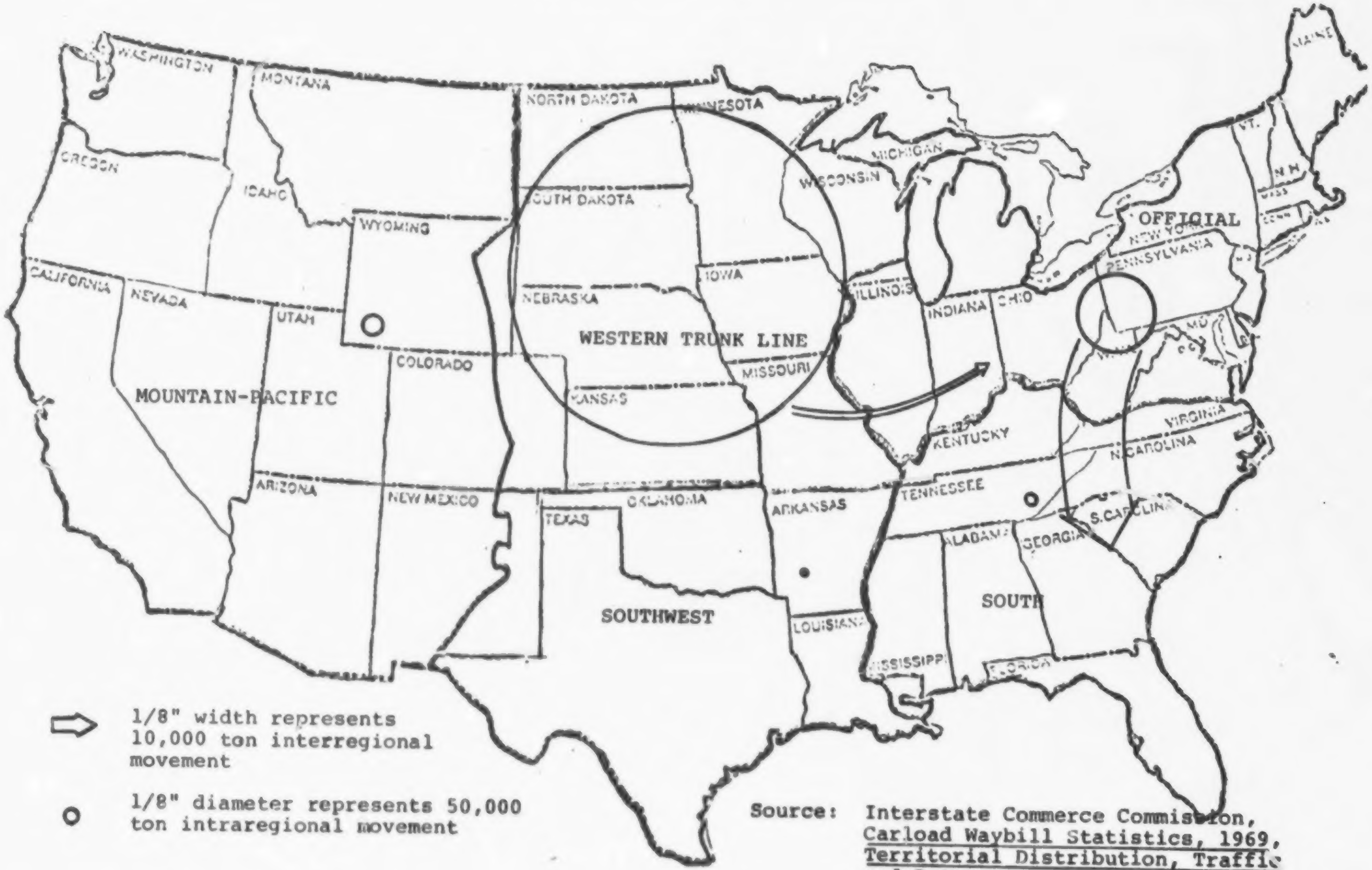
[7] Table B-1, Appendix B, provides a more detailed breakdown for all inland water carrier movements for 1971.

Figure 4-5. Interregional and Intraregional Rail Movements of Iron Ore - 1969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MASS
CONN
OREGON
IDAHO
SOUTH DAKOTA
WYOMING
OFFICIAL
NEW YORK
PENNSYLVANIA
CALIFORNIA
NEVADA
UTAH
NEBRASKA
IOWA
ILLINOIS
INDIANA
OHIO
MD
WESTERN TRUNK LINE
COLORADO
MISSOURI
MOUNTAIN-PACIFIC
KANSAS
KENTUCKY
VIRGINIA
N.CAROLINA
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
TENNESSEE
TEXAS
ALABAMA
GEORGIA
S.CAROLINA
SOUTHWEST
SOUTH
LOUISIANA
MISSISSIPPI
FLORIDA
1/8" width represents 10,000 ton interregional movement
1/8" diameter represents 50,000 ton intraregional movement

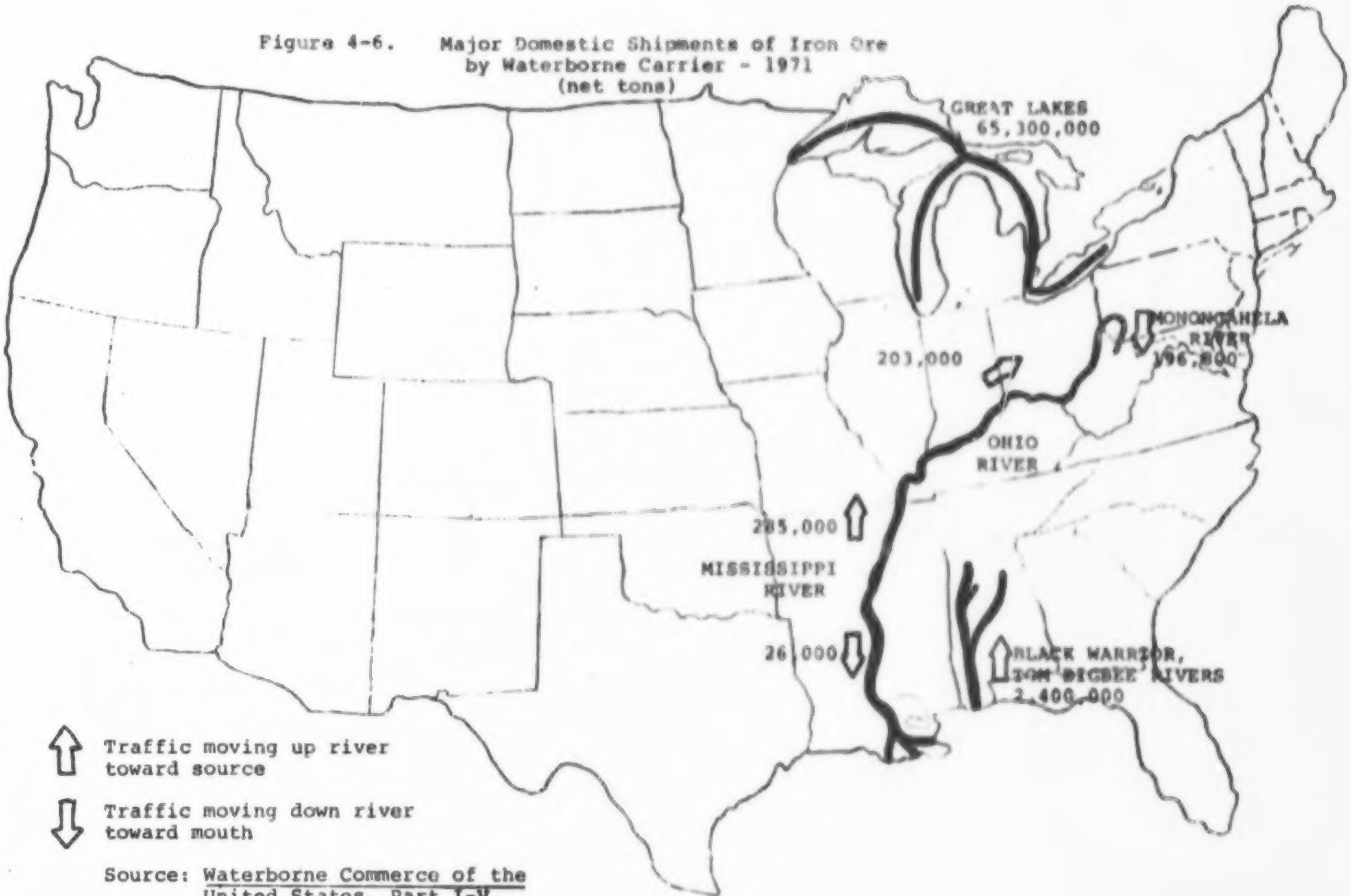
Source: Interstate Commerce Commission, Carload Waybill Statistics, 1969, Territorial Distribution, Traffic and Revenue.

Table 4-4. INTERREGIONAL AND INTRAREGIONAL RAIL MOVEMENTS OF IRON ORE-1969

Territorial movement	Number of tons
Official to Official	368,550
Official to Southern	43,300
Southern to Southern	41,000
Western Trunk Line to Western Trunk Line	972,850
Western Trunk Line to Official	4,250
Southwestern to Southwestern	10,700
Mountain Pacific to Mountain Pacific	105,800

Source: Department of Transportation, Carload Waybill Statistics 1969, Territorial Distribution, Traffic and Revenue, April 1972.

Figure 4-6. Major Domestic Shipments of Iron Ore by Waterborne Carrier - 1971 (net tons)


GREAT LAKES
65,300,000
203,000
MONONGAHELA
RIVER
196,800
OHIO
RIVER
285,000
MISSISSIPPI
RIVER
26,000
BLACK WARRIOR,
TOM BIGBEE RIVERS
2,400,000

⇧ Traffic moving up river toward source

⇩ Traffic moving down river toward mouth

Source: Waterborne Commerce of the United States, Part I-V. Calendar Year 1971.

Table 4-5. AVERAGE RAIL HAUL DISTANCE FOR VIRGIN AND SECONDARY STEEL RAW MATERIALS - 1969

Average rail haul distance, short haul miles

Movement-region	Virgin materials					Secondary materials	Difference between iron ore and scrap iron and steel*
	Iron ore	Coal	Pig iron	Coke	Lime-stone	Scrap iron & steel	
Nationwide (US to US)	237	250	NA	338	NA	150	87
Official (OFF to OFF)	189	249	NA	194	NA	108	81
Southern (SOU to SOU)	170	211	NA	220	NA	165	5
Western Trunk Line (WTL to WTL)	255	119	NA	415	NA	238	17
Southwestern (SW to SW)	310	-	NA	368	NA	236	74
Mountain Pacific (MTP to MTP)	239	203	NA	441	NA	144	95

* Positive sign shows virgin material moves farther

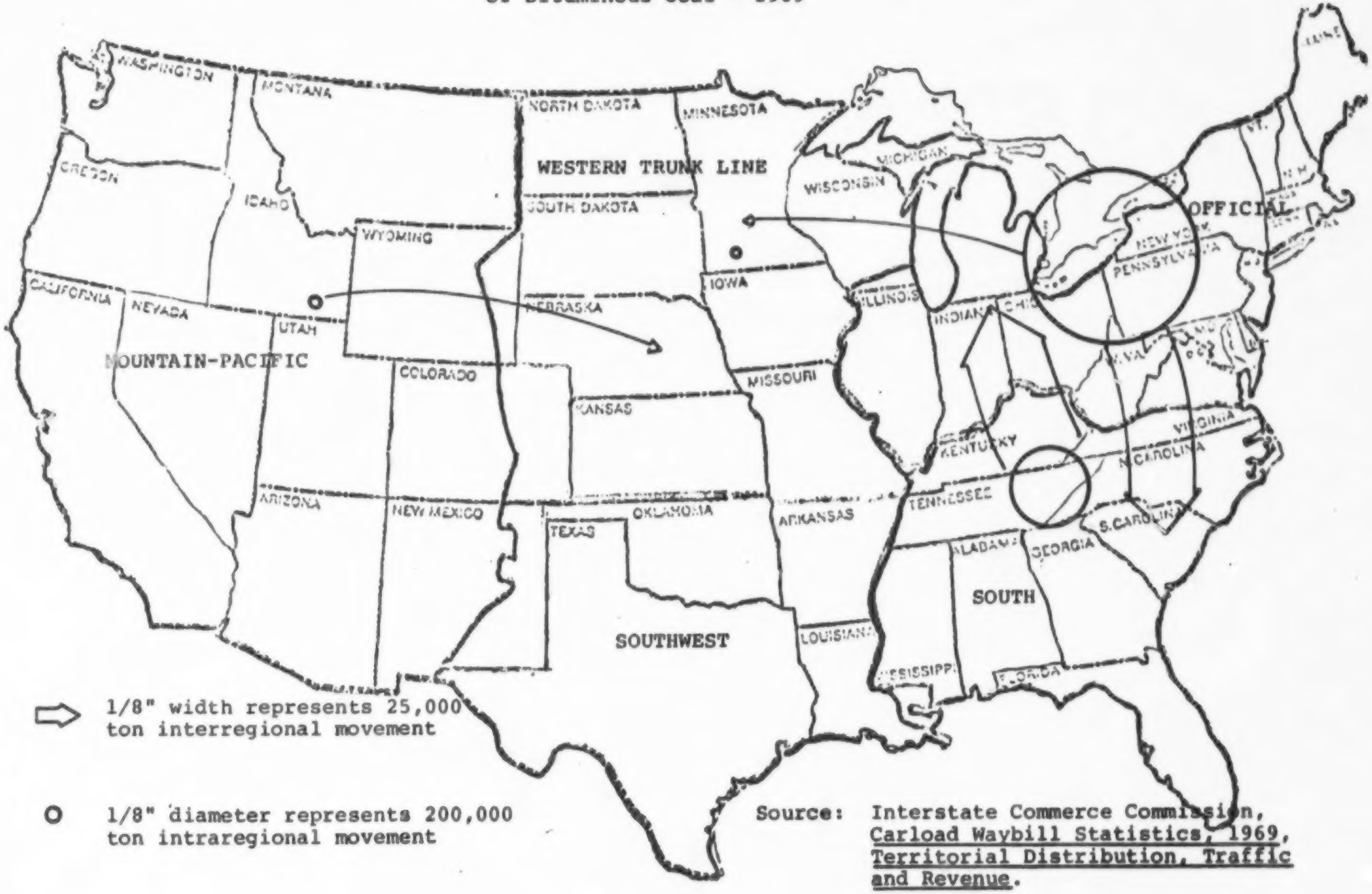
Source: Office of Systems Analysis and Information, Department of Transportation, Carload Waybill Statistics, 1969, Territorial Distribution, Traffic and Revenue by Commodity Classes, April, 1972.

The network of water systems in the steel-producing regions are used extensively to move coking coal and fluxing limestone to the mills. It has not been possible to trace explicitly the movement of coking coal as a separate commodity from the general commodity of bituminous coal on either of the two transport modes. Likewise, available statistical data will not allow fluxing limestone to be shown as a separate commodity. Thus, statistics are presented for the more generalized categories of bituminous coal and limestone. However, the data which are shown in Figures 4-7, 4-8, 4-9 and 4-10 (pgs. 52, 54, 55, and 57) should provide at least a partial indication of the more special categories since the steel industry is a major consumer of both limestone and bituminous coal and since fluxing limestone and coking coal are important subcategories of these general commodities.

The relatively small movement of coke shown in Figures 4-11 (p. 58) and 4-12 (p. 60) indicates that non-integrated steel mills using virgin materials are not extensive. Much of the movement shown in these figures is probably market coke moving between an integrated mill with an abundance of coke and an integrated mill with insufficient coke. An interesting aspect of coke movement is the interregional activity. The Eastern and Southern steel mills exchange a large amount of coke but they also ship a significant amount to the West and Southwest. The Western mills find it cheaper to buy their coke than to develop local sources. It should also be noted that the 1969 movements were made at a time of generally high economic activity. Eastern mills were producing at near-capacity and may have had a surplus of coke to sell. The longer interregional movements are influential in raising the average haul of coke to 338 miles (Table 4-5, p. 50).

The movement of scrap iron and steel is closely associated with the spatial distribution of scrap dealers and electric furnaces as shown in Figure 4-4 (p. 43). The concentration of population and electric furnaces along the lower Great Lakes correlates well with the movement of scrap shown in Figures 4-13 (p. 61) and 4-14 (p. 63). The interregional movement to the South, Southwest and West is indicative of the proliferation of electric furnaces and the relatively small supply of scrap in these areas. The 1969 movement of scrap from the West to the East and Southwest probably resulted from the increased demands of the Eastern mills during the boom years of 1968 and 1969. As shown in Table 4-5 (p. 50) the scrap moved an average distance of 150 miles; this was

Figure 4-7. Interregional and Intraregional Rail Movements of Bituminous Coal - 1969


WESTERN TRUNK LINE
OFFICIAL
MOUNTAIN-PACIFIC
SOUTHWEST
SOUTH
WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
OREGON
IDAHO
WYOMING
SOUTH DAKOTA
WISCONSIN
MICHIGAN
NEW YORK
PENNSYLVANIA
IOWA
NEBRASKA
CALIFORNIA
NEVADA
UTAH
ILLINOIS
INDIANA
OHIO
COLORADO
KANSAS
MISSOURI
W. VA.
VIRGINIA
KENTUCKY
N. CAROLINA
TENNESSEE
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
S. CAROLINA
TEXAS
ALABAMA
GEORGIA
LOUISIANA
MISSISSIPPI
FLORIDA
N.H.
VT.
1/8" width represents 25,000 ton interregional movement
1/8" diameter represents 200,000 ton intraregional movement

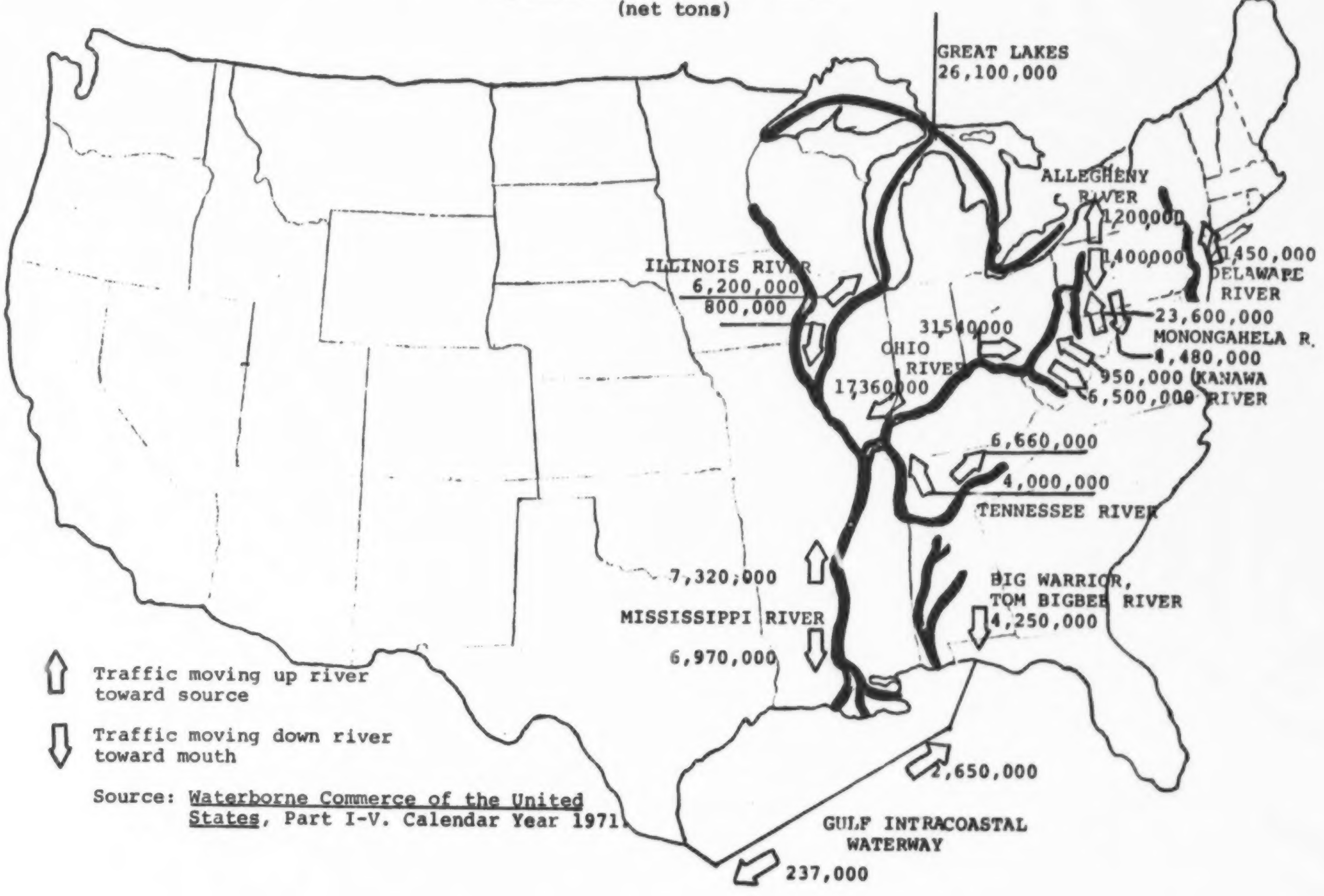
Source: Interstate Commerce Commission, Carload Waybill Statistics, 1969, Territorial Distribution, Traffic and Revenue.

Table 4-6. INTERREGIONAL AND INTRAREGIONAL RAIL MOVEMENTS OF COAL-1969

Territorial movement	Number of tons
Official to Official	2,377,240
Official to Southern	129,050
Official to Western Trunk Line	3,100
Southern to Southern	752,900
Southern to Official	161,200
Western Trunk Line to Western Trunk Line	75,700
Mountain Pacific to Mountain Pacific	109,800
Mountain Pacific to Western Trunk Line	7,100

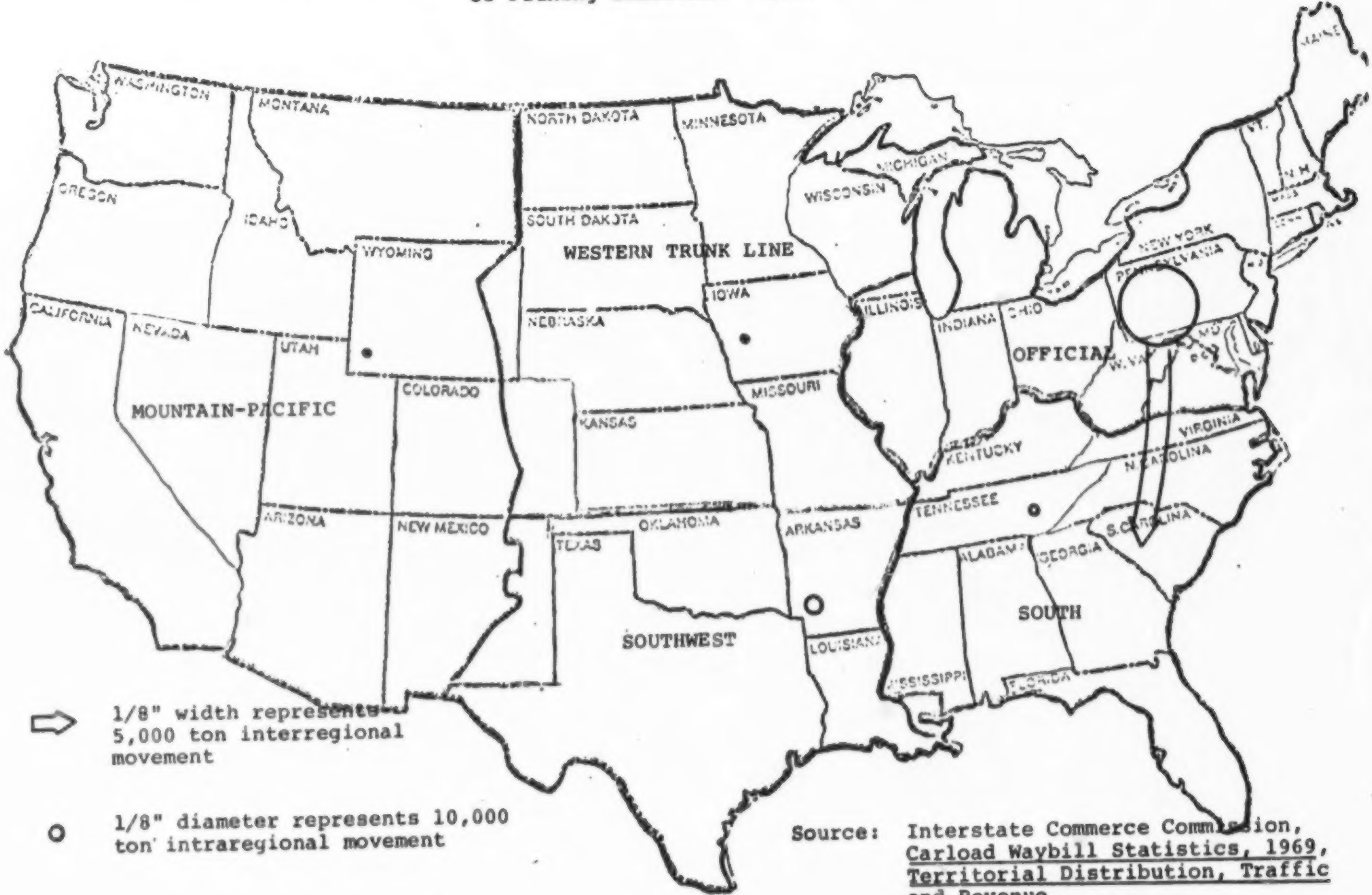
Source: Department of Transportation, Carload Waybill Statistics 1969, Territorial Distribution, Traffic and Revenue, April 1972.

Figure 4-8. Major Domestic Shipments of Coal by Waterborne Carrier - 1971 (net tons)


GREAT LAKES
26,100,000
ALLEGHENY RIVER
1200000
1400000
1,450,000
DELAWARE RIVER
23,600,000
MONONGAHELA R.
4,480,000
950,000
6,500,000
KANAWA RIVER
ILLINOIS RIVER
6,200,000
800,000
31540000
OHIO RIVER
17360000
6,660,000
4,000,000
TENNESSEE RIVER
7,320,000
MISSISSIPPI RIVER
6,970,000
BIG WARRIOR, TOM BIGBEE RIVER
4,250,000
2,650,000
GULF INTRACOASTAL WATERWAY
237,000
⇧ Traffic moving up river toward source
⇩ Traffic moving down river toward mouth

Source: Waterborne Commerce of the United States, Part I-V. Calendar Year 1971.

Figure 4-9. Interregional and Intraregional Rail Movements of Fluxing Limestone - 1969


WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
MICHIGAN
WISCONSIN
MAINE
VT.
N.H.
OREGON
IDAHO
WYOMING
SOUTH DAKOTA
WESTERN TRUNK LINE
NEW YORK
PENNSYLVANIA
IOWA
CALIFORNIA
NEVADA
UTAH
NEBRASKA
ILLINOIS
INDIANA
OHIO
OFFICIAL
W. VA.
MD
MOUNTAIN-PACIFIC
COLORADO
KANSAS
MISSOURI
KENTUCKY
VIRGINIA
N. CAROLINA
ARIZONA
NEW MEXICO
TEXAS
OKLAHOMA
ARKANSAS
TENNESSEE
S. CAROLINA
ALABAMA
GEORGIA
SOUTH
SOUTHWEST
LOUISIANA
MISSISSIPPI
FLORIDA
1/8" width represents 5,000 ton interregional movement
1/8" diameter represents 10,000 ton intraregional movement

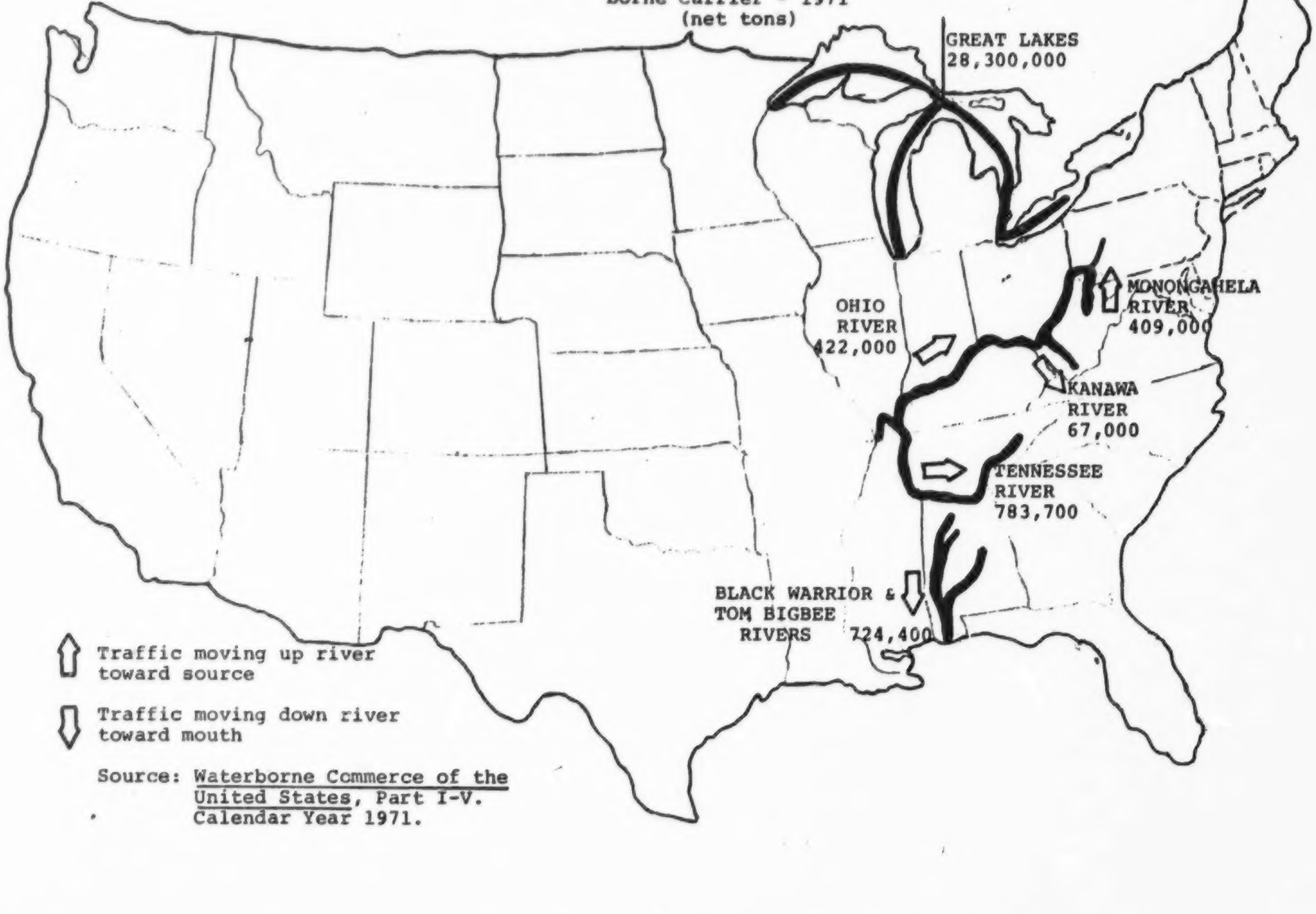
Source: Interstate Commerce Commission, Carload Waybill Statistics, 1969, Territorial Distribution, Traffic and Revenue.

Table 4-7. INTERREGIONAL AND INTRAREGIONAL RAIL MOVEMENTS OF LIMESTONE-1969

Territorial movement	Number of tons
Official to Official	74,814
Official to Southern	7,392
Southern to Southern	5,924
Western Trunk Line to Western Trunk Line	509
Southwestern to Southwestern	12,561
Mountain Pacific to Mountain Pacific	1,923

Source: Department of Transportation, Carload Waybill Statistics 1969, Territorial Distribution, Traffic and Revenue, April 1972.

Figure 4-10. Major Domestic Shipments of Limestone Flux and Calcareous Stone by Waterborne Carrier - 1971 (net tons)

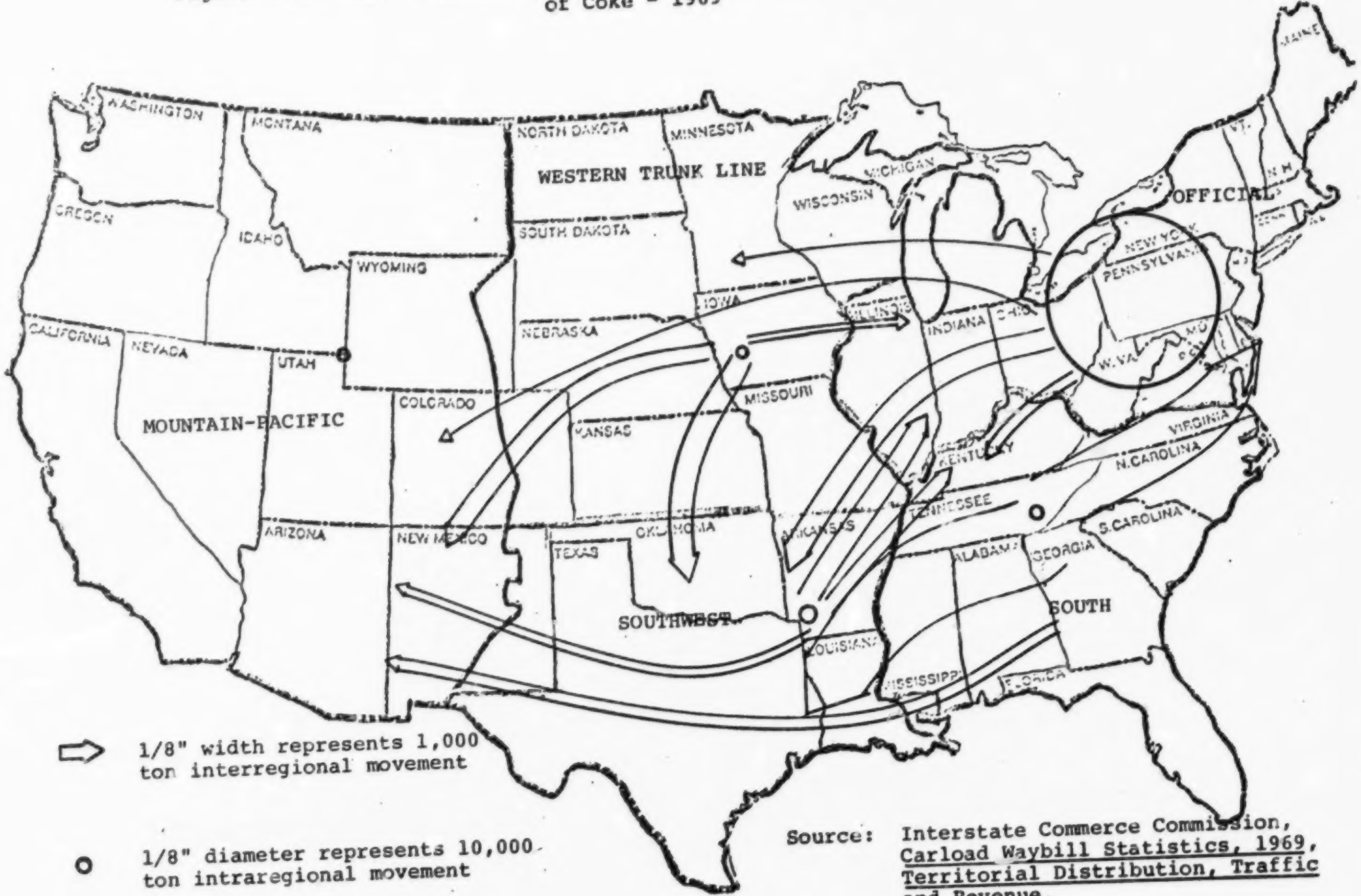

GREAT LAKES
28,300,000
OHIO RIVER
422,000
MONONGAHELA RIVER
409,000
KANAWA RIVER
67,000
TENNESSEE RIVER
783,700
BLACK WARRIOR & TOM BIGBEE RIVERS
724,400

⇧ Traffic moving up river toward source

⇩ Traffic moving down river toward mouth

Source: Waterborne Commerce of the United States, Part I-V. Calendar Year 1971.

Figure 4-11. Interregional and Intraregional Rail Movements of Coke - 1969


WESTERN TRUNK LINE
OFFICIAL
MOUNTAIN-PACIFIC
SOUTHWEST
SOUTH
WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
WISCONSIN
MICHIGAN
MAINE
VT.
N.H.
OREGON
IDAHO
SOUTH DAKOTA
WYOMING
NEW YORK
PENNSYLVANIA
IOWA
ILLINOIS
INDIANA
OHIO
CALIFORNIA
NEVADA
UTAH
NEBRASKA
W.VA.
MD
COLORADO
MISSOURI
KANSAS
VIRGINIA
KENTUCKY
N.CAROLINA
TENNESSEE
ARIZONA
NEW MEXICO
OKLAHOMA
ARKANSAS
S.CAROLINA
TEXAS
ALABAMA
GEORGIA
LOUISIANA
MISSISSIPPI
FLORIDA
1/8" width represents 1,000 ton interregional movement
1/8" diameter represents 10,000 ton intraregional movement

Source: Interstate Commerce Commission, Carload Waybill Statistics, 1969, Territorial Distribution, Traffic and Revenue.

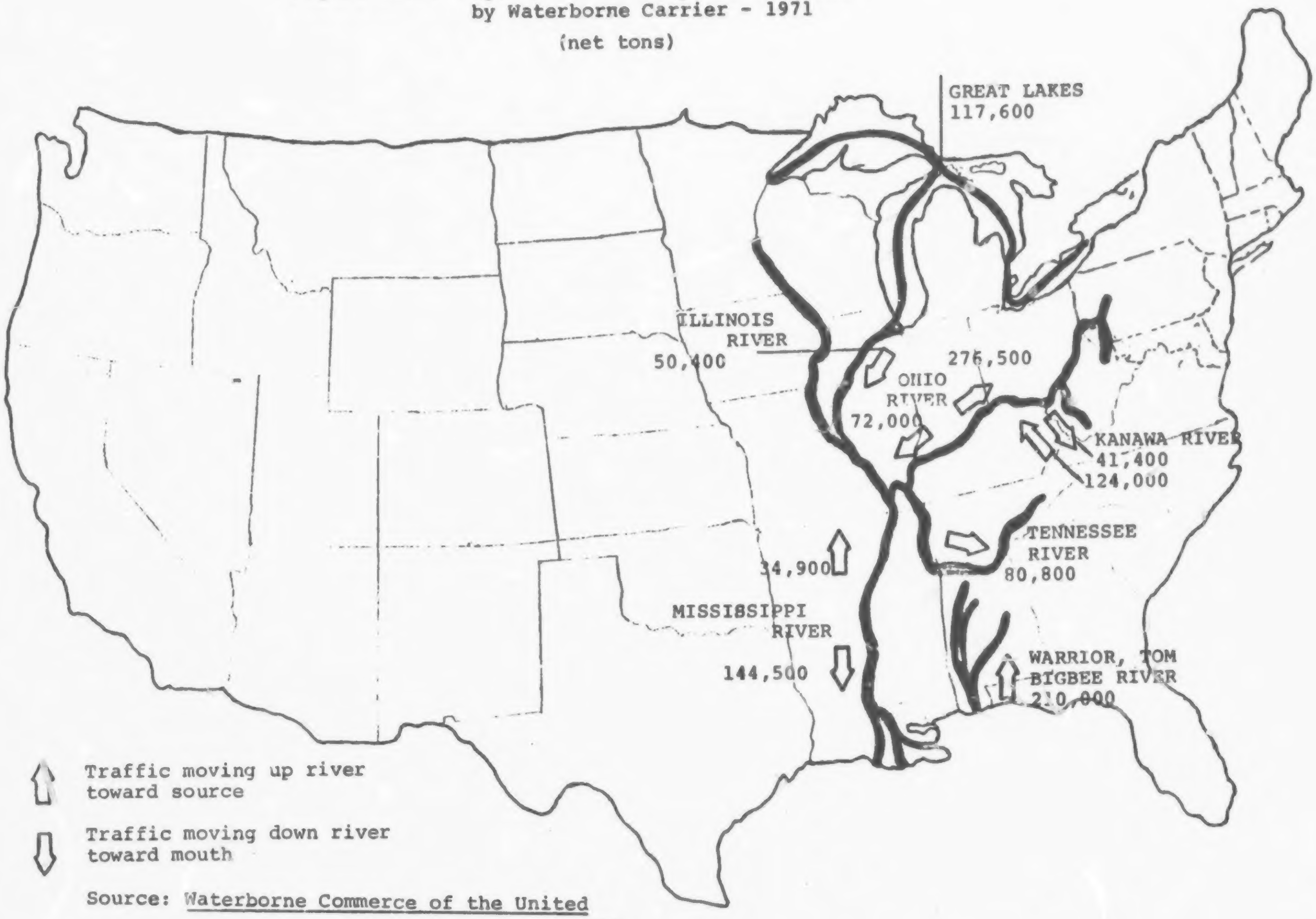
Table 4-8. INTERREGIONAL AND INTRAREGIONAL RAIL MOVEMENTS OF COKE-1969

Territorial movement	Number of tons
Official to Official	98,890
Official to Southern	715
Official to Western Trunk Line	180
Official to Southwestern	1,690
Official to Mountain Pacific	290
Southern to Southern	10,280
Southern to Official	5,615
Southern to Southwestern	6,465
Southern to Mountain Pacific	470
Western Trunk Line to Western Trunk Line	7,665
Western Trunk Line to Official	520
Western Trunk Line to Southwestern	1,705
Western Trunk Line to Mountain Pacific	1,305
Southwestern to Southwestern	12,065
Southwestern to Official	1,135
Southwestern to Southern	615
Southwestern to Mountain Pacific	415
Mountain Pacific to Mountain Pacific	10,075

Source: Department of Transportation, Carload Waybill Statistics 1969, Territorial Distribution, Traffic and Revenue, April 1972.

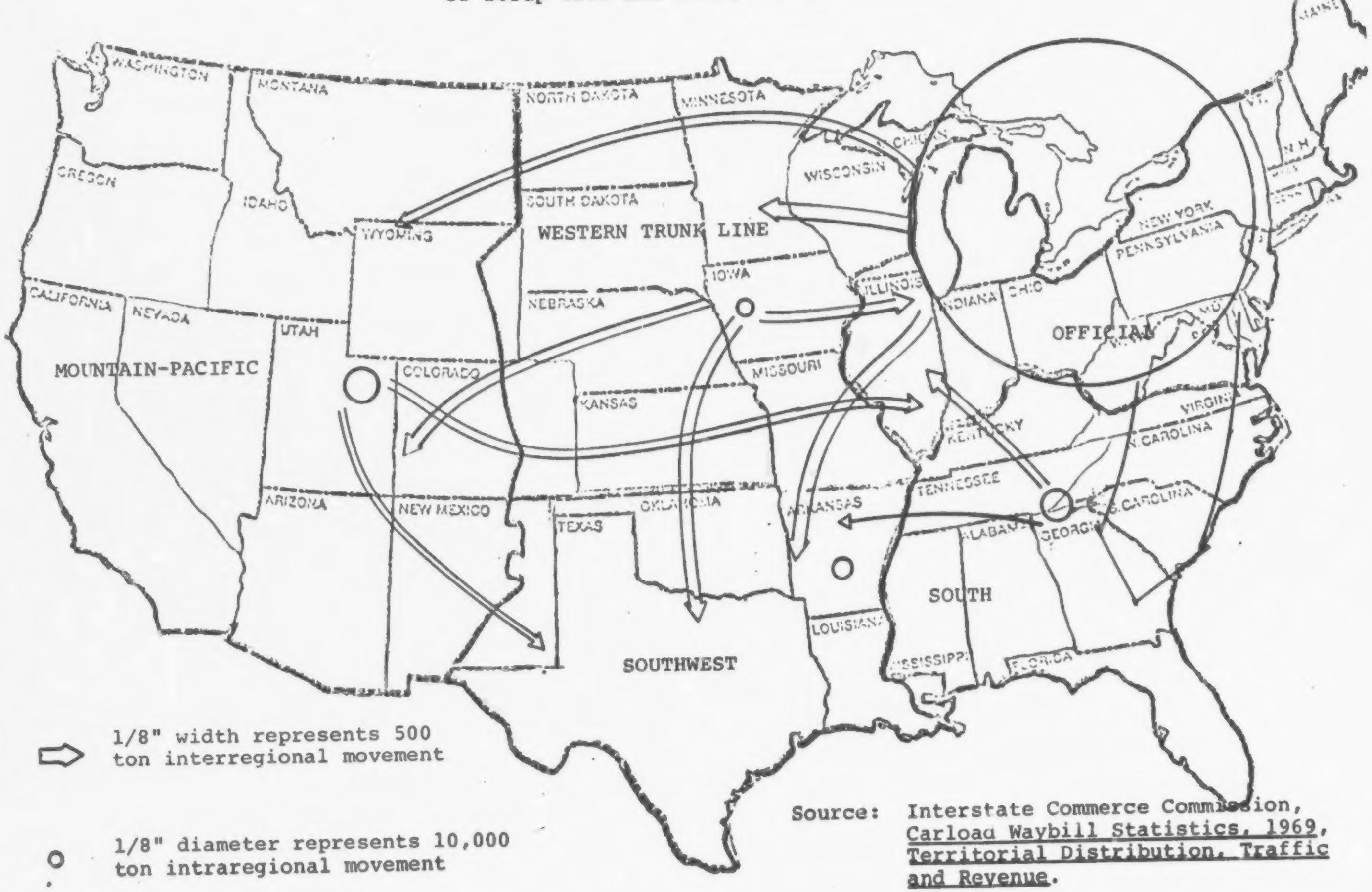
Figure 4-12. Major Domestic Shipments of Coke by Waterborne Carrier - 1971

(net tons)


GREAT LAKES
117,600
ILLINOIS
RIVER
50,400
276,500
OHIO
RIVER
72,000
KANAWA RIVER
41,400
124,000
TENNESSEE
RIVER
80,800
34,900
MISSISSIPPI
RIVER
144,500
WARRIOR, TOM
BIGBEE RIVER
210,000
⇧ Traffic moving up river toward source
⇩ Traffic moving down river toward mouth

Source: Waterborne Commerce of the United States, Part I-V. Calendar Year 1971.

Figure 4-13. Interregional and Intraregional Rail Movements of Scrap Iron and Steel - 1969


WASHINGTON
MONTANA
NORTH DAKOTA
MINNESOTA
OREGON
IDAHO
WISCONSIN
MICHIGAN
SOUTH DAKOTA
WYOMING
WESTERN TRUNK LINE
NEW YORK
PENNSYLVANIA
IOWA
ILLINOIS
INDIANA
OHIO
CALIFORNIA
NEVADA
NEBRASKA
UTAH
OFFICIAL
MOUNTAIN-PACIFIC
COLORADO
MISSOURI
KANSAS
KENTUCKY
VIRGINIA
N. CAROLINA
TENNESSEE
S. CAROLINA
ARIZONA
NEW MEXICO
TEXAS
OKLAHOMA
ARKANSAS
ALABAMA
GEORGIA
SOUTH
LOUISIANA
SOUTHWEST
MISSISSIPPI
FLORIDA
MAINE
VT.
N.H.
MD.

1/8" width represents 500 ton interregional movement

1/8" diameter represents 10,000 ton intraregional movement

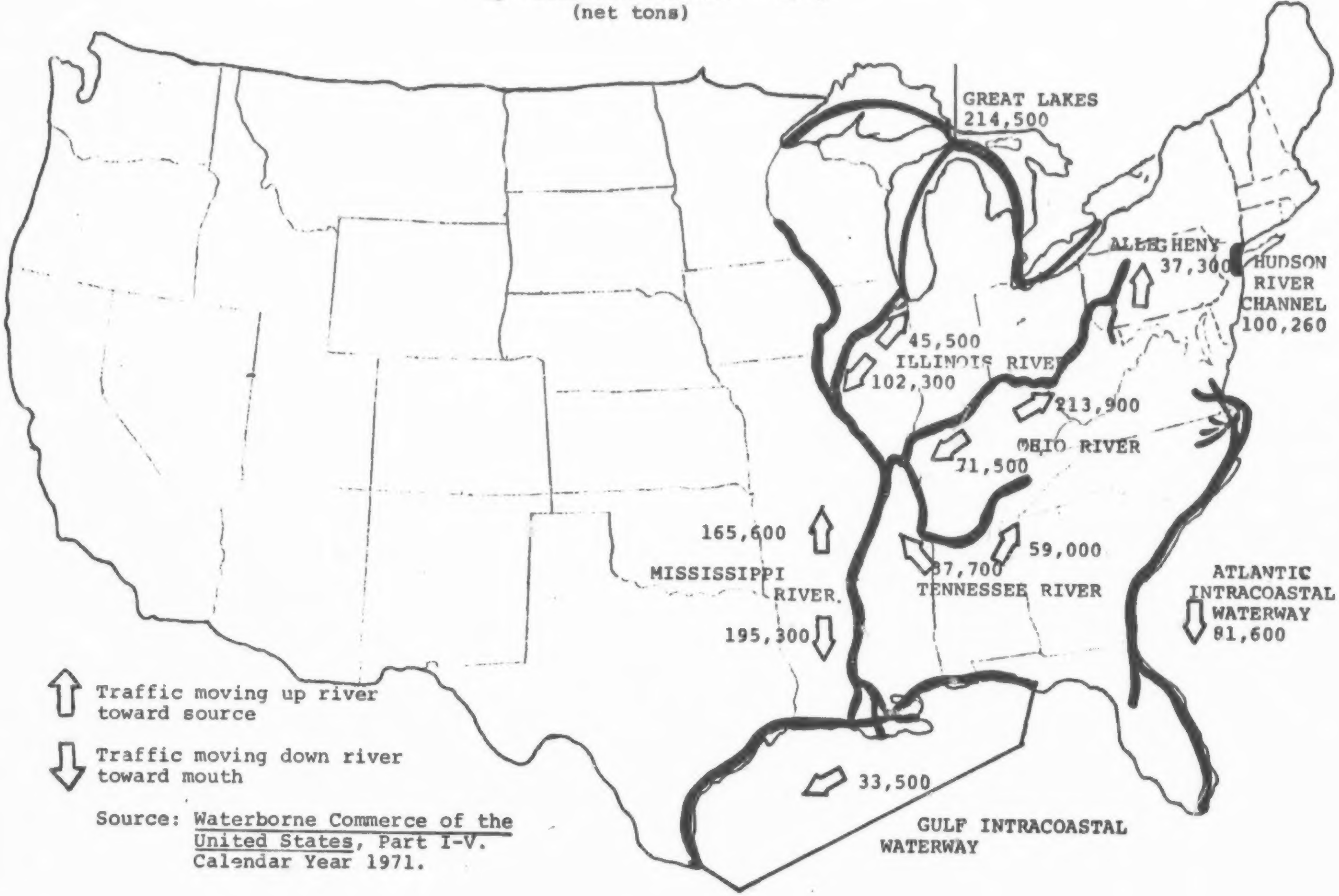
Source: Interstate Commerce Commission, Carload Waybill Statistics, 1969, Territorial Distribution, Traffic and Revenue.

Table 4-9. INTERREGIONAL AND INTRAREGIONAL RAIL MOVEMENTS OF SCRAP IRON AND STEEL - 1969

Territorial movement	Number of tons
Official to Official	207,450
Official to Southern	3,315
Official to Western Trunk Line	455
Official to Southwestern	590
Official to Mountain Pacific	530
Southern to Southern	25,615
Southern to Official	410
Southern to Southwestern	145
Western Trunk Line to Western Trunk Line	10,465
Western Trunk Line to Official	490
Western Trunk Line to Southwestern	685
Western Trunk Line to Mountain Pacific	495
Southwestern to Southwestern	15,310
Mountain Pacific to Mountain Pacific	29,160
Mountain Pacific to Official	505
Mountain Pacific to Southwestern	295

Source: Department of Transportation, Carload Waybill Statistics 1969, Territorial Distribution, Traffic and Revenue, April 1972.

Figure 4-14. Major Domestic Shipments of Scrap Iron and Steel by Waterborne Carrier - 1971 (net tons)


GREAT LAKES
214,500
ALLEGHENY
37,300
HUDSON
RIVER
CHANNEL
100,260
45,500
ILLINOIS RIVER
102,300
213,900
OHIO RIVER
71,500
165,600
59,000
MISSISSIPPI
RIVER
87,700
TENNESSEE RIVER
ATLANTIC
INTRACOASTAL
WATERWAY
81,600
195,300
33,500
GULF INTRACOASTAL
WATERWAY
⇧ Traffic moving up river toward source
⇩ Traffic moving down river toward mouth

Source: Waterborne Commerce of the United States, Part I-V. Calendar Year 1971.

87 miles less than the average iron ore shipment. These relatively short movements result from the tendency of the electric furnaces to be located near scrap-generating population centers. The movement of scrap by water is broadly distributed among Eastern waterways. Of note is the relatively large quantity of scrap moving on the Great Lakes. While this movement is generally confined to the lower Lakes, it is also subject to some of the cold weather transportation costs associated with the two-phase iron ore movement. However, the low proportion of scrap moving on the Lakes serves to balance the impact of these cold weather costs.

INDUSTRY CHARACTERISTICS - PAPER AND PAPERBOARD

Paper and Paperboard Production

Roundwood, for example, pulpwood or pulpwood logs, roundwood residues and wastepaper contribute more than 98 percent of the fiber for making paper and paperboard. Straw, rags and other fibrous materials currently comprise less than 2 percent of the industry's fiber sources.[8]

Trees specifically harvested for wood pulp are termed roundwood. Roundwood residues are by-products of trees harvested for lumber and forest products other than pulp. Wood chips are the major source of residue fibers while sawdust, and cuttings and various other by-products complete the remainder of the residue fiber sources.

Roundwood and residues are technically equivalent fiber substitutes for making wood pulp. For purposes of this study, the residues and roundwood are considered virgin fiber sources in the production of paper and paperboard. Technically, the residues are a secondary material, but, in fact, they are a direct derivative of the roundwood and are pulped in the same equipment as if they were roundwood. Many times roundwood is processed into chips to improve its transportability, and roundwood is also usually chipped before being made into pulp. In addition, forest production practices treat the residues as essential products rather than as secondary materials to be disposed of in the most convenient manner.

The structure of the production process in the paper and paperboard industry is strongly influenced by whether virgin materials or wastepaper is used as the primary raw material. Paper and paperboard made from wood pulp is usually produced in an integrated facility which combines either a pulp mill and a paper mill, or a pulp mill and a board mill, or all three. The integrated unit is usually located near a lumber operation to facilitate access to lumber mill residues and to sources of roundwood. Proximity of the lumber mill and the forest reserve is necessary to reduce raw materials transportation costs. As the Wall Street Journal has said, "Vertically integrated paper mills are, of course, generally influenced by proximity to the industry's chief materials--trees and water."[9]

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[8] American Paper Institute, Pulp and Raw Materials Group, Wood Pulp Statistics - 1972, 36th Edition, October 1972, p. 59.

The use of wastepaper in the integrated facilities has been discouraged because of the ready availability of pulp from nearby mills and because of the high cost to transport wastepaper from the population centers which generate it to the mills in the relatively remote South and Pacific Northwest.

The integrated pulp and paper mills are usually owned and operated by vertically integrated forest product companies. Many times these companies own or lease the forest resources, the lumber mills, the pulp mills, the paperboard mills and the paper product converting plants. This chain of ownership creates economies of scale and more significantly provides complete managerial control over supply sources and production activities. Significant to this study is the fact that vertical integration enables the company to establish a very efficient transportation system through the placement of production facilities near supplies. The efficiencies of the system and the companies' size allows them to exert tremendous leverage in bargaining for rates with private carriers. Given this situation, transportation costs for virgin raw materials can reach relatively low levels.

The use of wastepaper as a fiber source has generally been limited to integrated paper and paperboard mills which do not have exclusive use of pulp mills. Technological developments, such as deinking for making tissue and newsprint, along with the public's increasing interest in recycling have worked to encourage non-integrated mills to employ wastepaper as a production input. This encouragement has fostered the growth of non-integrated mills near populated urban areas and the conversion of older mills in the Northeast and North Central states to use of wastepaper. The converted mills are often facilities which were formerly operated with virgin materials from the now-depleted forest reserves of the Northeast. In some cases, the conversion to 100 percent wastepaper usage is not complete. As a Wall Street Journal article suggests:

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[9] "Paper Industry Confronted With Shortages of Used Boxes That it Needs for Recycling," Wall Street Journal, May 7, 1973.

> As for non-integrated paper and paperboard mills, their location is likely to be affected more by proximity to markets than by the location of raw materials. However, the sites of such mills may also be dictated by the availability of different types of pulp and wastepaper.[10]

Between 1950 and 1968, the building of new mills using wastepaper inputs and the conversion of old mills to wastepaper from virgin pulp generally did not exceed the closing of mills which formerly used wastepaper. The result, as detailed in Figure 4-15 (p. 68), has been a relatively steady decline in the proportion of paper fiber derived from wastepaper. The renewed interest in wastepaper during the mid-1960's has tended to reverse this downward trend, and since 1968, the proportion of wastepaper being consumed has risen slightly. Integrated mills have been using residues in increasing proportion and have slackened in their employment of roundwood as shown by the plots. The Midwest Research Institute (MRI) in a recent report on paper recycling projected that, by 1985, the proportion of roundwood fibers will decline by 5 percent while the proportion of residues will remain approximately constant and the wastepaper proportion will increase by 5 percent.[11]

Paperboard production represents the primary use for fibers derived from wastepaper. Table 4-10 (p. 69) shows that in 1970, nearly 70 percent of all wastepaper was consumed in paperboard production and that a single category of paperboard, combination board, used more than 60 percent of the wastepaper fiber. Construction paper and board and tissue paper consumed most of the remaining secondary fiber.

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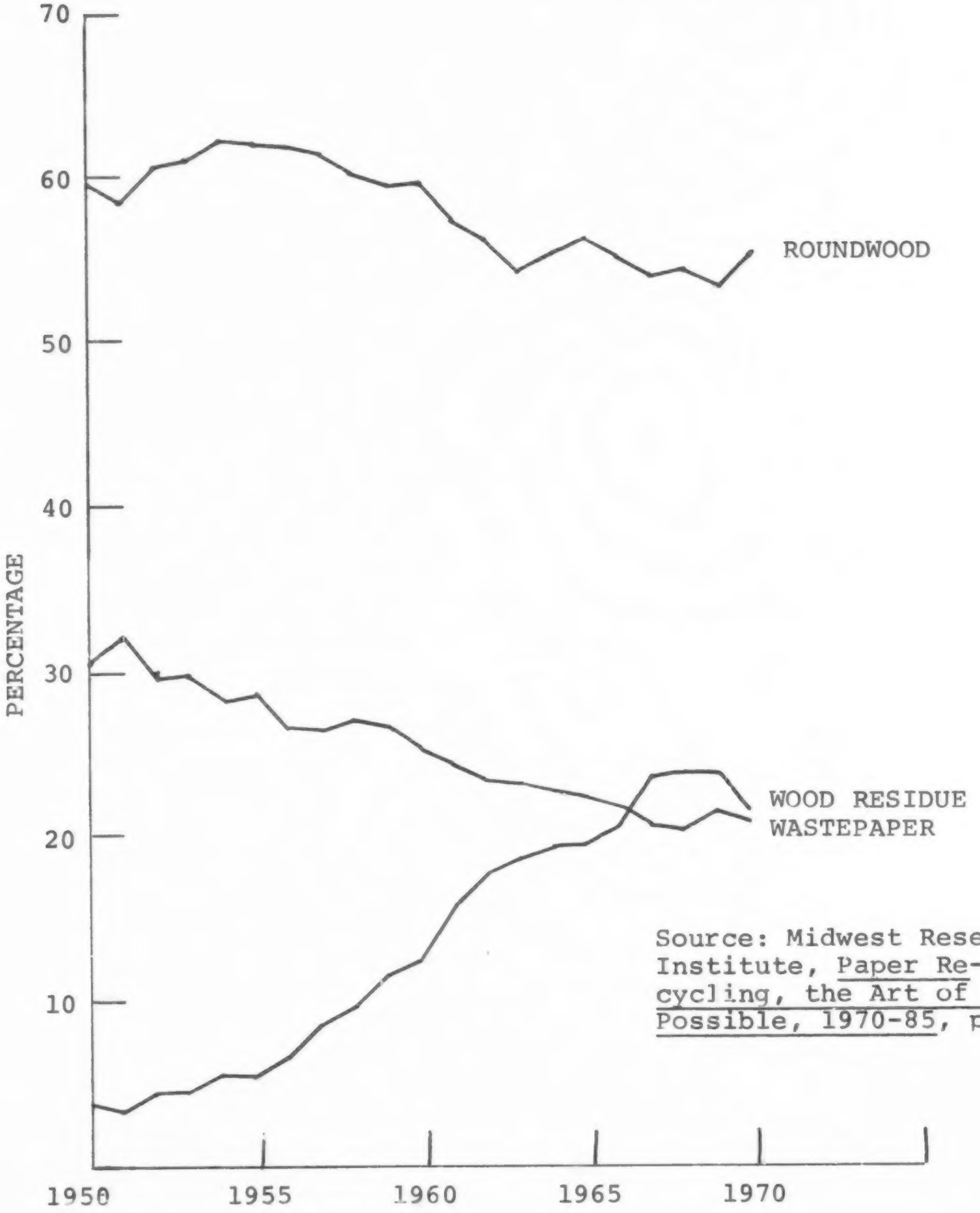
[10] Ibid.

[11] Franklin, W.E., Hunt, R.G. and Sharp, S.T., Paper Recycling: The Art of the Possible 1970-1985. Kansas City, Missouri: Midwest Research Institute, 1973. This report was prepared for the Solid Waste Council of the Paper Industry, March, 1973.

Figure 4-15. Raw Materials Consumed in the Manufacture of Paper and Paperboard



Source: Midwest Research Institute, Paper Recycling, the Art of the Possible, 1970-85, p. 7.

Table 4-10. WASTE PAPER UTILIZATION IN PAPER AND PAPERBOARD MANUFACTURE - 1970
(thousand tons)

End product	Total U.S. production	Total waste paper consumption	Mixed papers	Newspapers	Corrugated	Pulp subs & high grade de-inking
Total all grades and molded pulp	53,329	12,021	2,639	2,235	4,080	3,067
Total paper	23,409	2,228	33	455	108	1,632
Newsprint	3,345	371	--	371	--	--
Printing, writing and related	11,023	736	--	--	--	736
Unbl. Kraft pkg, ind. conv. special ind. and other	5,446	150	26	8	39	77
Tissue	3,595	971	7	76	69	819
Total paperboard	25,465	8,330	1,766	1,473	3,779	1,312
Unbleached Kraft and solid bleached	15,036	285	48	8	162	67
Semi-chemical	3,460	754	42	28	622	62
Combination	6,969	7,291	1,676	1,437	2,995	1,183
Construction paper & board, molded pulp and other	4,455	1,463	840	307	193	123
Distribution-Percent		100.0%	22.0%	18.6%	33.9%	25.5%

Source: Midwest Research Institute, Paper Recycling, the Art of the Possible 1970-1985, 1973, p. 52.

Wastepaper and virgin pulp compete as potential fiber sources in the paper and paperboard categories where wastepaper presently has a significant proportion of the total fiber input. Technical and economic factors have limited substitutability in the other categories. MRI has identified six of the paper and paperboard categories where wastepaper can offer a future competitive advantage over virgin pulp: linerboard, corrugating medium, folding boxboard, newsprint, print/writing and tissue. A company anticipating future expansion of its capacity to produce any one of these paper products might face the choice of building an integrated plant using roundwood and residues as production inputs or building a non-integrated plant relying on wastepaper for raw materials.

To see how raw material transportation costs might influence inputs decision, a single paperboard product category has been selected for study. This product is "corrugating medium."[12] Corrugating medium is the center material in corrugated boxboard; linerboard is the smooth material covering the medium. Corrugating medium (hereafter referred to as medium) is usually produced in the facility which also makes the linerboard. If a company decides to make its linerboard from virgin pulp, then it is highly likely that the medium will be produced from virgin material, as well. On the other hand, linerboard also represents a potential use for secondary fibers and a mill designed to produce medium and linerboard from wastepaper is a technically and economically feasible endeavor. It is also possible that a mill can use virgin inputs for linerboard and wastepaper for medium. For purposes of this study, the production of linerboard is not considered a problem, and the choice of a raw material has been assumed to be made on the basis of the medium. MRI has characterized the potential for using wastepaper in making medium as follows:

> Corrugated medium using recycled fiber can be produced on a technically equivalent basis to semichemical medium, using post-consumer wastepaper in the form of old corrugated boxes. Both of these products are used interchangeably,

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[12] Out of the six major paper grades (mentioned above) accounting for 70 percent of paper industry tonnage and offering greatest potential recycled paper usage, corrugating medium is predicted to use the greatest amount of wastepaper.

> although not usually so. Recycled corrugating medium is cost competitive with semichemical medium.
>
> Increased recycling can be accomplished by using 100 percent wastepaper in the form of old corrugated or by using supplemental wastepaper in semichemical mills. However, it is likely that 100 percent wastepaper operation is more favorable. The use of wastepaper in corrugating medium could increase to 5.0 million tons by 1985 compared to 1.4 million tons in 1970.[13]

The Source of Raw Materials -

Roundwood and wood chips usually move into the integrated mills by a transportation network established by the large vertically integrated companies which own the mills. The network extends from the forest to the paper- and board-producing plants. The prompt industrial scrap which these mills use is generally moved from the converting mills to the pulp mills by carriers who primarily haul finished paper and board to the converting mills. This type of movement is usually characterized as a haul-back or back-haul, since the carrier would normally return empty if the scrap were available.

Wastepaper moves to consuming mills through a network of collectors, dealers, processors and brokers similar to the scrap iron and steel industry. The wastepaper generated by this network either moves directly to the consuming mill or through a processor's yard. The direct movement is usually from large commercial establishments which have processing equipment to prepare the wastepaper for shipment. The wastepaper processor is usually involved in this movement by serving as the broker who establishes a market for the commercial establishment's waste and who arranges for transportation. The broker/processor arranges to pick up and ship the wastepaper to the consuming mill and makes provision for payment and collection. The broker must be prepared to respond quickly to the waste generated by the commercial establishments since these companies have very little room for wastepaper inventory. The transportation from the generating establishment to the mill is usually by truck. Often the broker/processor will provide the truck, but he may also hire carriages or trucks owned by the paper mill. Mill trucks are sometimes used for haul-backs of waste materials from the mill to the scrap processor.

---

[13] Franklin, W.E., Paper Recycling: The Art of the Possible 1970-1985.

The wastepaper which moves through the processor's yard is sorted and baled for easy transport. The commercial establishments which ship directly have their own baling equipment which eliminates the necessity of moving the wastepaper to the processor. Prior to being baled, the waste is usually shredded to allow a more compact bale to be made; bales generally weigh between 1600 and 2200 pounds. The baler and the shredder represent the primary technological innovations in the processing of wastepaper. The recent increase in use of balers at large wastepaper-generating sites has been a major improvement in establishing a viable wastepaper collection system. As in the previous case, the processor arranges shipment of wastepaper bales from his yard to the mill. Again, trucks are the major means of transportation used for this haul and the distribution of truck ownership is similar to that mentioned above.

Paper producers can purchase wastepaper either f.o.b. the processor's or supplier's dock or else f.o.b. the mill dock. In either case, the processor or broker generally arranges the transportation. Neither pricing practice can be said to dominate over the other, and the use of each is widespread throughout the industry.

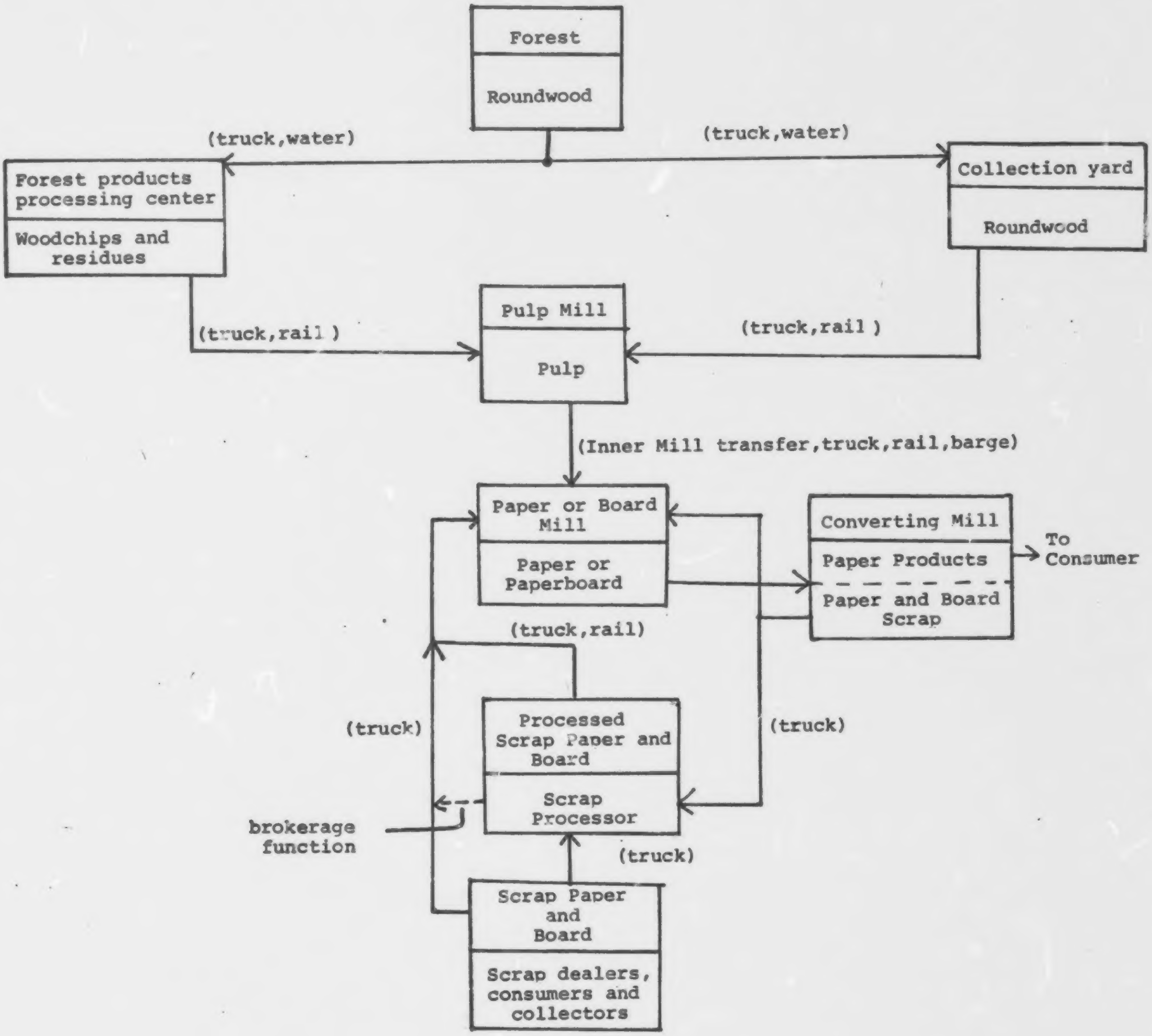
Transportation Modes -

Figure 4-16 (p. 73) summarizes the virgin and secondary raw material supply networks in the paper industry. The primary transportation modes used for each haul are shown in parentheses.

Table 4-11 (p. 74) illustrates that rail is the major transportation mode for moving virgin paper raw materials; truck is the major mode for moving wastepaper. Inland water transportation hauls only a minor proportion of either type of commodity.

The roundwood used in the South is usually moved from logging areas to large collection yards by truck and

Figure 4-16. Transportation Modes Used to Move Raw Materials in the Paper and Board Industries


Forest
Roundwood
(truck,water)
(truck,water)
Forest products processing center
Woodchips and residues
Collection yard
Roundwood
Pulp Mill
Pulp
(truck,rail)
(truck,rail)
(Inner Mill transfer,truck,rail,barge)
Paper or Board Mill
Paper or Paperboard
Converting Mill
Paper Products
Paper and Board Scrap
To Consumer
(truck,rail)
(truck)
(truck)
Processed Scrap Paper and Board
Scrap Processor
brokerage function
(truck)
Scrap Paper and Board
Scrap dealers, consumers and collectors

( ) indicates principal transportation mode used to move commodities

Table 4-11. COMMODITY MOVEMENT BY TRANSPORTATION MODE - 1970
Paper Making Materials

Transportation mode	Amount of commodity moved (thousands of net tons)			
	Round-wood	Wood chips & residue	Pulp	Waste paper
Class I & II railroads	45,444	20,936	5,217	4,275
Class I motor carriers	9.2	1,427	230	36.6
Private and other than Class I motor carriers	NA	NA	NA	7,000[1]
Domestic water traffic	1,827.1	1,333.7	1,095.8	34.3
Total consumption of commodity in paper industry	67,524	14,000	43,494*	11,800

* production figures
1 RPA estimate
NA - not available
Note: The sum of the movements by mode may exceed consumption or production because of two mode movements to transport the commodity to the processing facility or because of alternate uses in other industrial products.
Source: American Paper Institute, The Statistics of Paper, 1972.

then loaded on railroad cars for the move to the mills. The trucks used in the first phase of this haul are either owned by the logging companies or private individuals. The railroad making the second phase haul is usually a common carrier, but in the case of some large integrated companies, the railroad is owned by the forest products company. Roundwood from the Pacific Northwest usually moves directly to the mill by rail. Wood chips and other residues also move primarily by rail, although trucks are beginning to haul this commodity. Movement of the virgin raw materials is characterized by large shipments, seasonal fluctuations, relatively predictable movements and specially designed equipment to move the commodities. Large shipments favor the use of rail, but the relatively aggressive trucking industry continues to increase the proportion of these commodities hauled by developing new technologies such as the wood chips trailer which unloads in less than three minutes.

Two factors--the diverse spatial characteristics of wastepaper suppliers and the relatively short hauls required to move most wastepaper--favor the use of trucks over rails and water. Trucks are flexible enough to conform to the intermittent demands of suppliers and are compatible with the relatively small loads that move at frequent intervals. In addition, many paper mills own trucking fleets to haul their finished products to market, and since the markets are usually near the wastepaper supplies, the back-haul of waste presents an attractive method for obtaining full utilization of the trucks. Thus, the trucks usually employed in hauling wastepaper are privately owned or leased by the paper mills. Contract carriers and trucks owned by dealer/processors provide a majority of the remaining motor vehicles.

Table 4-11 summarizes the amount of virgin and secondary raw materials and wood pulp hauled by the various transportation modes. The lack of information on the amount of these commodities hauled by private motor carriers limits the extent of this analysis. However, the amount of roundwood or pulpwood and the amount of wastepaper hauled by private motor carrier can be approximated by subtracting the sum of the rail, common motor carrier and inland water carrier movements from total consumption.[14] This deductive methodology, unfortunately, cannot be applied to residues or wood pulp because all residues are not consumed in making paper and most wood pulp never leaves the integrated mills. Carrying out the calculations shows that approximately 30 percent of the roundwood is moved by private motor carrier while 64 percent of wastepaper is moved by this mode. These figures give substantial evidence to general patterns of movements outlined in the preceding subsection.

---

[14] This neglects the roundwood moved by private railroads mentioned earlier. This mode, however, carries only a small fraction of the total roundwood moved.

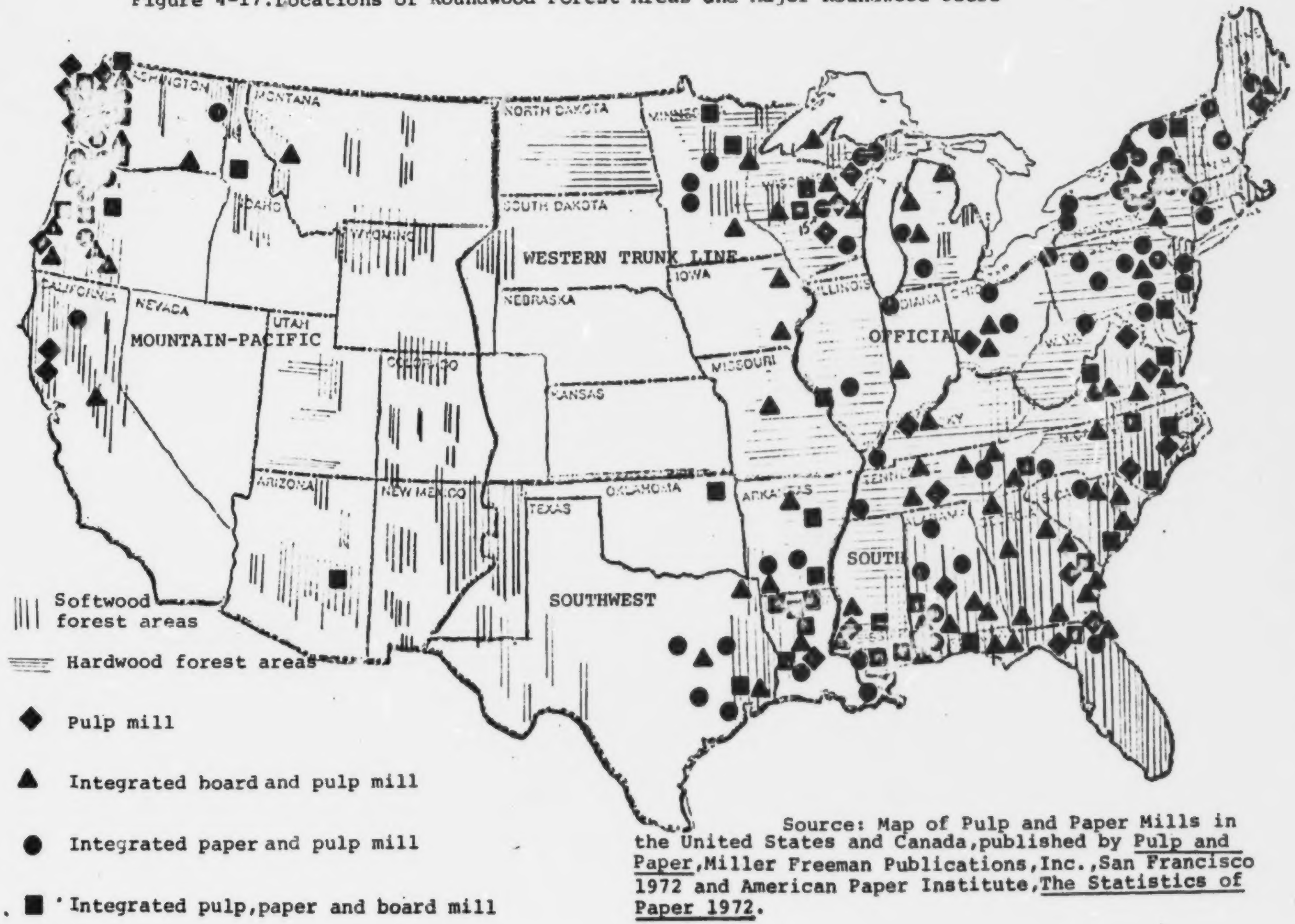
The data in Table 4-11 also provide some evidence that integrated mills produce the majority of paper and paperboard made from virgin raw materials. The data show that less than 15 percent of all the pulp consumed in 1970 became market pulp which was moved by the major transportation modes. The remaining 85 percent of pulp derived from virgin sources was consumed in integrated mills. This calculation does not take into account any pulp hauled by private carriers, as well as any pulp exchanged between integrated mills. While statistics are not available on either of these amounts, discussions with paper industry personnel have indicated that both the pulp hauled by private motor carriage and the pulp exchanged between integrated mills would each be a relatively small and negligible proportion of market pulp.

Spatial Characteristics -

This subsection outlines in greater detail the relative locations of forests mills and scrap suppliers referred to in previous discussions. These locations will provide a convenient reference for the movements described in the subsequent subsection and the analysis in Chapter V.

Figure 4-17 (p. 77) plots the location of both the major domestic forest reserves, and the pulp mills and integreated paper and board plants which use virgin resources from these areas. The locations of the mills closely correspond to the location of available forest reserves. The forests of the South and Pacific Northwest have an abundance of pulp, paper and board mills. In the Northeast and North Central states the expanding human population is depleting forest reserves, and as a result, mills are closing down. Tables 4-31 (p.253) and 4-32 (p. 254) outline numerically the relative amounts of roundwood produced and consumed by the mill concentrations. The concentration of mills in the South and Northwest are responsible for nearly 90 percent of the total pulp

Figure 4-17.Locations of Roundwood Forest Areas and Major Roundwood Users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CALIFORNIA
NEVADA
UTAH
MOUNTAIN-PACIFIC
COLORADO
KANSAS
MISSOURI
ILLINOIS
INDIANA
OHIO
OFFICIAL
KENTUCKY
TENNESSEE
ARIZONA
NEW MEXICO
TEXAS
OKLAHOMA
ARKANSAS
ALABAMA
GEORGIA
SOUTH
SOUTHWEST
||| Softwood forest areas
≡ Hardwood forest areas
◆ Pulp mill
▲ Integrated board and pulp mill
● Integrated paper and pulp mill
■ Integrated pulp,paper and board mill

Source: Map of Pulp and Paper Mills in the United States and Canada,published by Pulp and Paper,Miller Freeman Publications,Inc.,San Francisco 1972 and American Paper Institute,The Statistics of Paper 1972.

production and consumption.

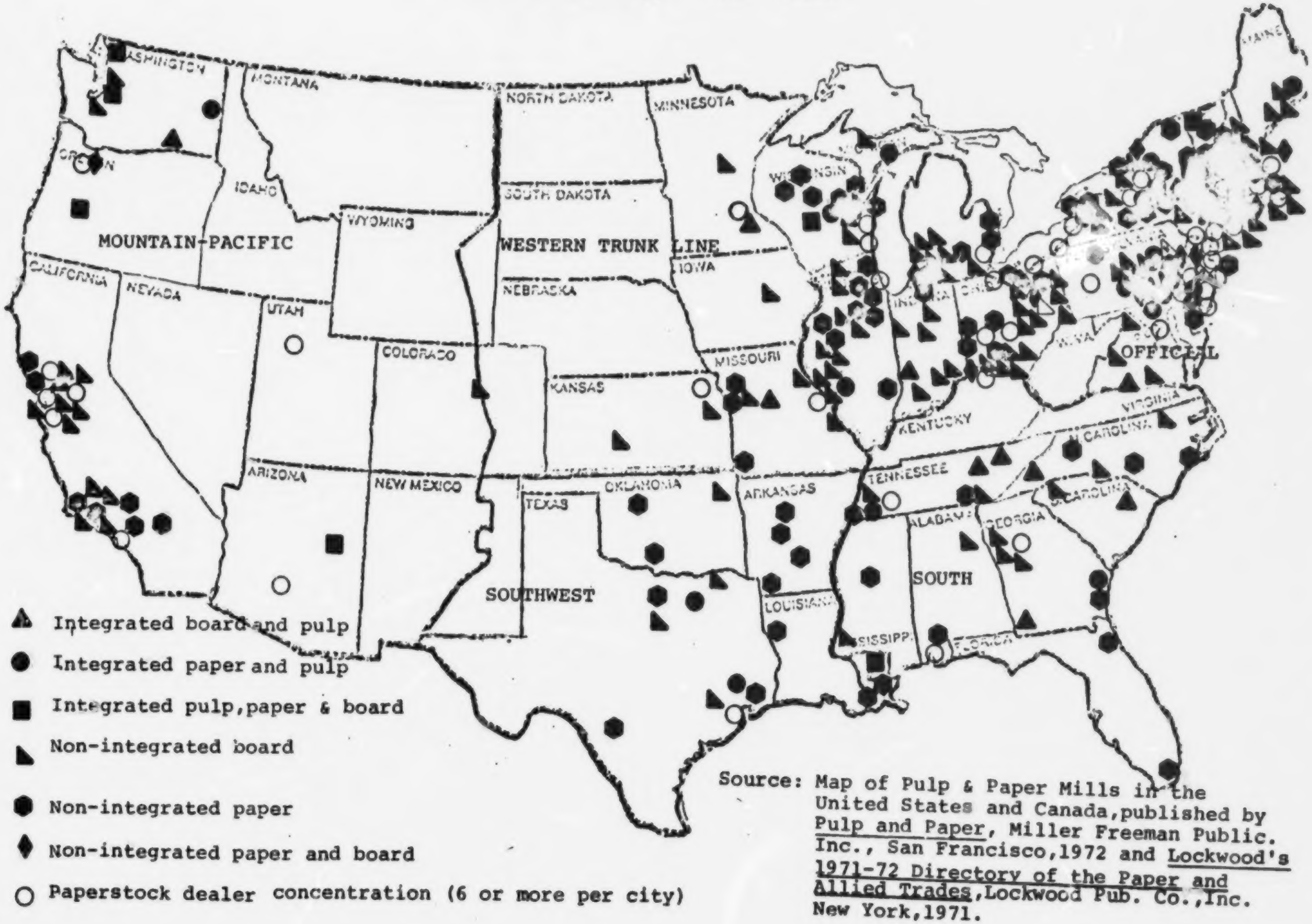
The location of paper and paperboard mills which use wastepaper and of wastepaper dealer and processor concentrations is shown in Figure 4-18 (p. 79). The North Central and Northeastern states are the areas where the majority of wastepaper consuming mills are located. Many mills in these areas have been converted to wastepaper as forest reserves have been depleted. Also evident from the figure is the dominance of non-integrated facilities among the wastepaper-consuming mills. The data in Table 4-12 (p. 80) show that the North Central and Northeastern states consume nearly 60 percent of the wastepaper, while the remainder is spread primarily among Southern and Western states. The open symbols on Figure 4-18 also show the close association between wastepaper dealers and major population centers.

Raw Materials Movement –

Movement patterns for virgin and secondary raw materials for paper were developed in the same way as were patterns of steel raw materials and from the same data sources. Railroad interregional and intraregional movements for 1969 and inland water carrier movements by river systems have been established for 1971. The lack of statistical data has precluded the development of quantitative descriptions of the raw material movements by either common or private motor carrier. However, discussions with paper and trucking industry personnel have provided sufficient information to present an informal description of motor vehicle movements.

The movement of roundwood from either the forest or the collection areas to the pulp mills has been shown to rely heavily on rail transport. Figure 4-19 (p. 81) and Table 4-13 (p. 82) show how the roundwood has been moved by railroads within and among regions in 1969. Shipments to the many Southern mills and shipments from the forests of the South to the pulp mills in the Northeast comprised the primary movements of roundwood by rail. The water movements shown in Figure 4-20 (p. 83) are also heavily concentrated in the South. There is, however, some Great Lakes movement from logging in Michigan, Minnesota and Wisconsin. The lack of either significant rail or water movements in the Northwest indicates that the mills in this area do not rely heavily on roundwood as a raw material, and that the roundwood which is used in this

Figure 4-18. Locations of Paperstock Dealer and Broker Concentrations and Major Paperstock Users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TEXAS
ARKANSAS
TENNESSEE
S. CAROLINA
ALABAMA
GEORGIA
SOUTH
SOUTHWEST
LOUISIANA
MISSISSIPPI
FLORIDA
▲ Integrated board and pulp
● Integrated paper and pulp
■ Integrated pulp, paper & board
◣ Non-integrated board
⬢ Non-integrated paper
♦ Non-integrated paper and board
○ Paperstock dealer concentration (6 or more per city)

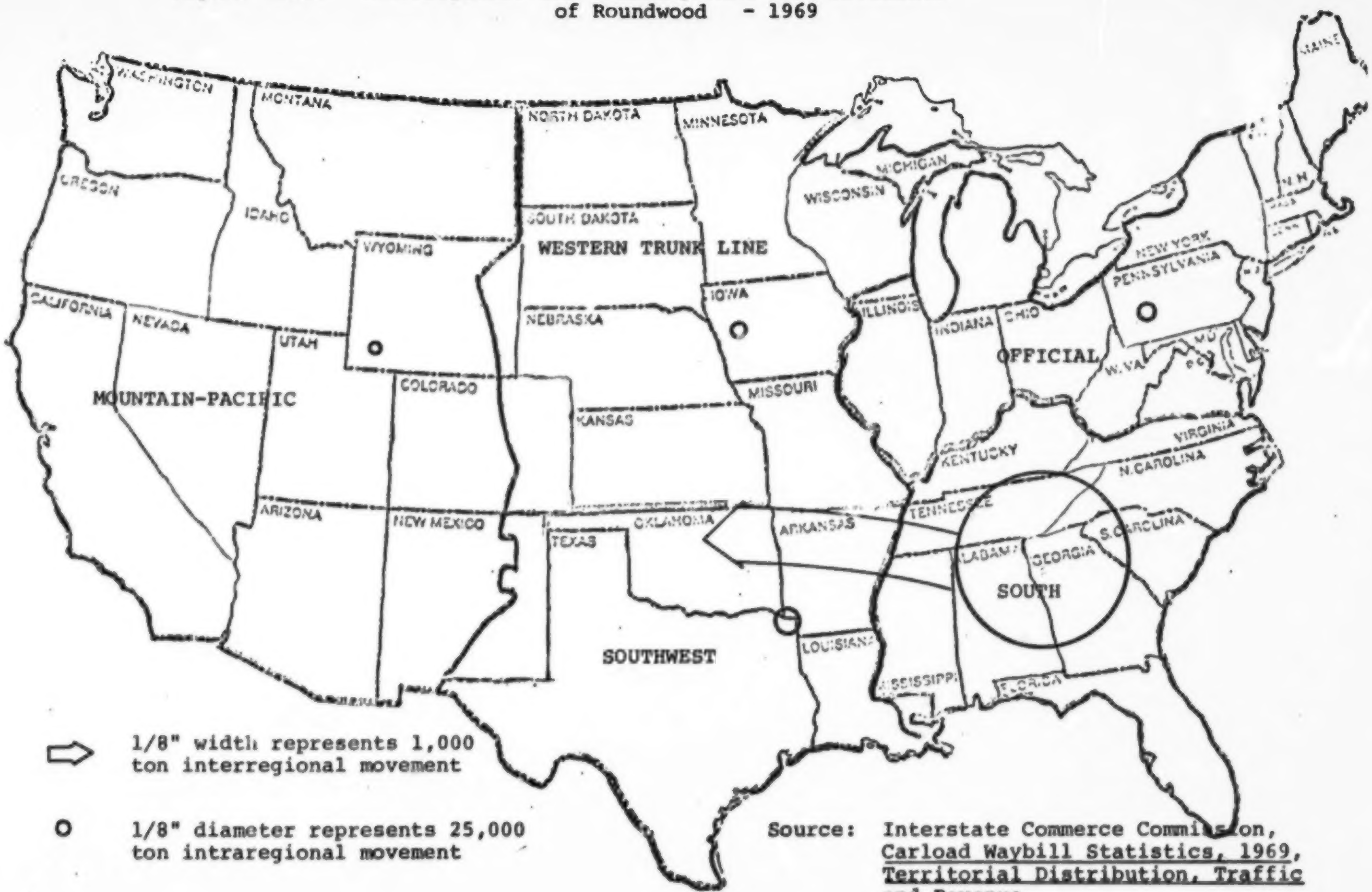
Source: Map of Pulp & Paper Mills in the United States and Canada, published by Pulp and Paper, Miller Freeman Public. Inc., San Francisco, 1972 and Lockwood's 1971-72 Directory of the Paper and Allied Trades, Lockwood Pub. Co., Inc. New York, 1971.

Table 4-12. PERCENT OF U.S. WASTEPAPER CONSUMPTION BY REGION - 1971

Region	Percent of Total U.S. Consumption
New England: Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island	9.0
Mid-Atlantic: New York, Pennsylvania, New Jersey	22.2
East North Central: Wisconsin, Illinois, Indiana, Michigan, Ohio	33.9
West North Central: North Dakota, South Dakota, Nebraska, Kansas, Iowa, Missouri, Minnesota	3.0
South Atlantic: Delaware, Maryland, West Virginia, Virginia, North Carolina, South Carolina, Georgia, Florida	11.0
East South Central: Kentucky, Tennessee, Mississippi, Alabama	4.5
West South Central: Oklahoma, Arkansas, Texas, Louisiana	4.6
Mountain & Pacific: Washington, Oregon, California, Nevada, Arizona, Utah, Idaho, Montana, Wyoming, Colorado, New Mexico	11.8

Source: American Paper Institute, Paper, Paperboard and Wood Pulp Capacity, Waste Paper Utilization, 1971-1974, 1972.

Figure 4-19. Interregional and Intraregional Rail Movements of Roundwood - 1969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WYOMING
WESTERN TRUNK LINE
NEW YORK
PENNSYLVANIA
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CALIFORNIA
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ALABAMA
GEORGIA
SOUTH
SOUTHWEST
LOUISIANA
MISSISSIPPI
FLORIDA
⇨ 1/8" width represents 1,000 ton interregional movement
○ 1/8" diameter represents 25,000 ton intraregional movement

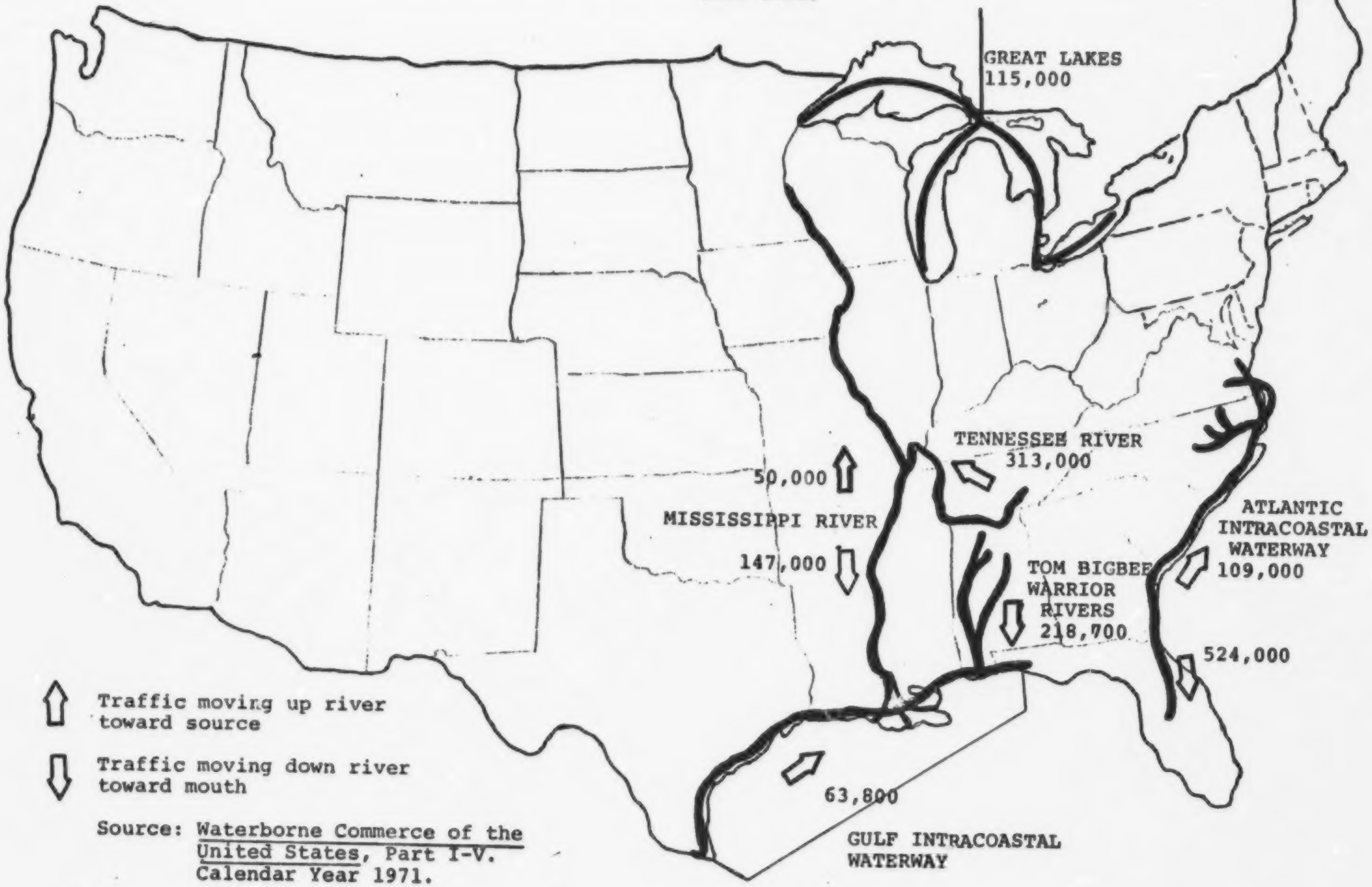
Source: Interstate Commerce Commission, Carload Waybill Statistics, 1969, Territorial Distribution, Traffic and Revenue.

Table 4-13. INTERREGIONAL AND INTRAREGIONAL RAIL MOVEMENTS OF ROUNDWOOD - 1969

Territorial movement	Number of tons
Official to Official	31,970
Southern to Southern	249,971
Southern to Southwestern	2,875
Western Trunk Line to Western Trunk Line	26,320
Southwestern to Southwestern	54,090
Mountain Pacific to Mountain Pacific	6,990

Source: Department of Transportation, Carload Waybill Statistics, 1969, Territorial Distribution, Traffic and Revenue, April 1972.

Figure 4-20. Major Domestic Shipments of Roundwood by Waterborne Carrier - 1971 (net tons)


GREAT LAKES
115,000
TENNESSEE RIVER
313,000
50,000 ⇧
MISSISSIPPI RIVER
147,000 ⇩
TOM BIGBEE WARRIOR RIVERS
218,700 ⇩
ATLANTIC INTRACOASTAL WATERWAY
109,000 ⇧
524,000 ⇩
63,800
GULF INTRACOASTAL WATERWAY
⇧ Traffic moving up river toward source
⇩ Traffic moving down river toward mouth

Source: Waterborne Commerce of the United States, Part I-V. Calendar Year 1971.

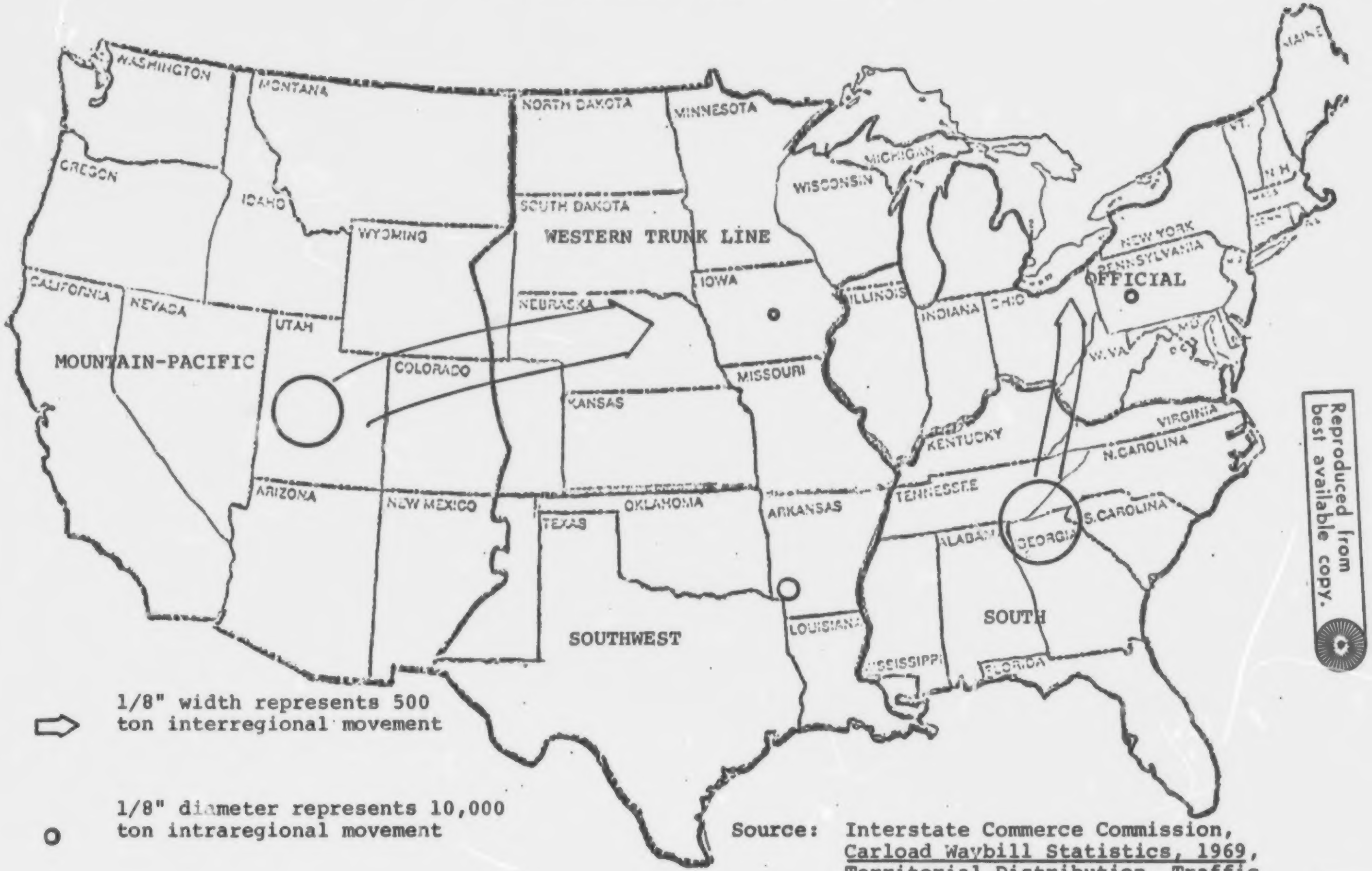
area is moving to the mills primarily by trucks. In addition to truck movement in the Northwest, many logs travel to mills by floating down the Northwest water systems; however, statistics on log rafts and floating logs do not appear in the waterborne carrier statistics. Private individuals usually transport Northwest logs to mills in company-owned trucks.

The heavy reliance of Southern mills on roundwood contrasts with the integrated Northwest mills' reliance on wood chips and residues. Figure 4-21 (p.85) and Table 4-14 (p. 86) show the preponderance of rail movement of residues in the West. The intraregional rail activity in this area is supplemented by export movements to other domestic regions. The movement by inland water carriers shown in Figure 4-22 (p. 87) reaffirms the popularity of residues in Western mills. The Willamette River is a major inland arterial for Western wood chips. Private truckers generally transport chips by motor carrier, usually a 20 to 25 ton trailer designed specifically for wood chips.

Figure 4-23 (p. 88) and Table 4-15 (p. 89) show the sample rail data for pulp movements in 1969. As mentioned previously approximately 15 percent of the pulp which is produced becomes market pulp and as can be seen from Figure 4-23 a large proportion of market pulp moved from pulp mills in the forest areas to mills which are not located near the trees. A significant amount of pulp moves within the Southern states, but the South and West also export pulp heavily to the mills in the North Central and Northeast states. The large upstream movements on the Mississippi River and Atlantic Intra-Coastal Waterway shown in Figure 4-24 (p. 90) also indicate that the non-integrated mills of the Northeastern and North Central areas make heavy purchases of market pulp from Southern mills. The movement of pulp by motor carrier is often made by company or private trucks over relatively short distances. Truck transportation is usually confined to intraregional movements.

The heavy concentration of wastepaper consuming mills in the Northeast and North Central states is indicative of the rail and water movements in these areas. Figures 4-25 (p. 91) and 4-26 (p. 93) and Table 4-16 (p. 92) show the heavy concentration of rail and water movements in these areas and the movement of wastepaper from the South and West into the North Central and Northeastern states. The figures, unfortunately, do not show the majority of wastepaper movement made by private motor carriers. The

Figure 4-21 Interregional and Intraregional Rail Movements of Wood Chips and Residue - 1969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GEORGIA
SOUTH
SOUTHWEST
LOUISIANA
MISSISSIPPI
FLORIDA

⇨ 1/8" width represents 500 ton interregional movement

○ 1/8" diameter represents 10,000 ton intraregional movement

Source: Interstate Commerce Commission, Carload Waybill Statistics, 1969, Territorial Distribution, Traffic and Revenue.

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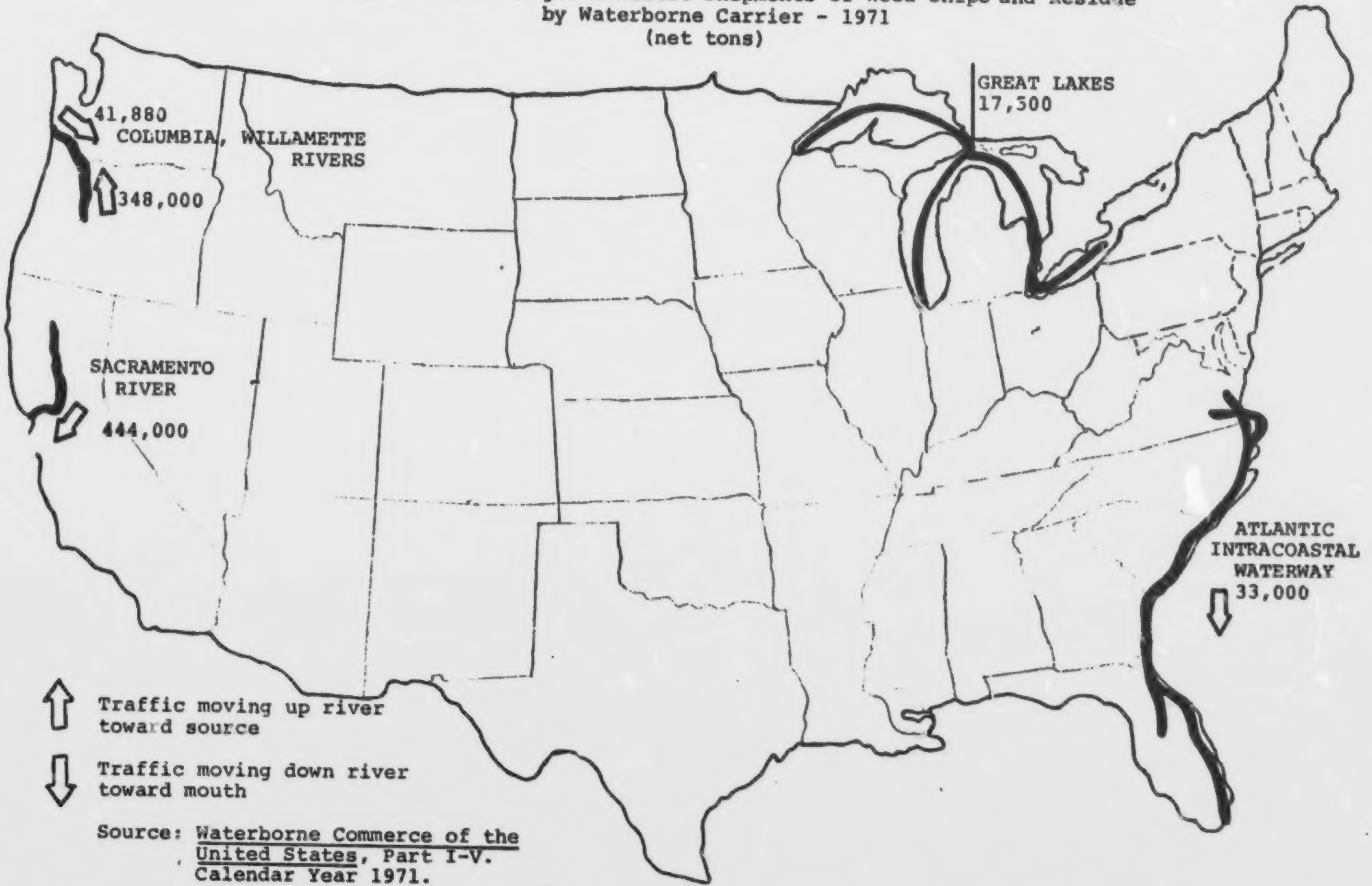
Table 4-14. INTERREGIONAL AND INTRAREGIONAL RAIL MOVEMENTS OF WOOD CHIPS AND RESIDUE - 1969

Territorial movement	Number of tons
Official to Official	6,515
Southern to Southern	74,951
Southern to Official	836
Western Trunk Line to Western Trunk Line	3,177
Southwestern to Southwestern	24,508
Mountain Pacific to Mountain Pacific	68,001
Mountain Pacific to Western Trunk Line	1,706

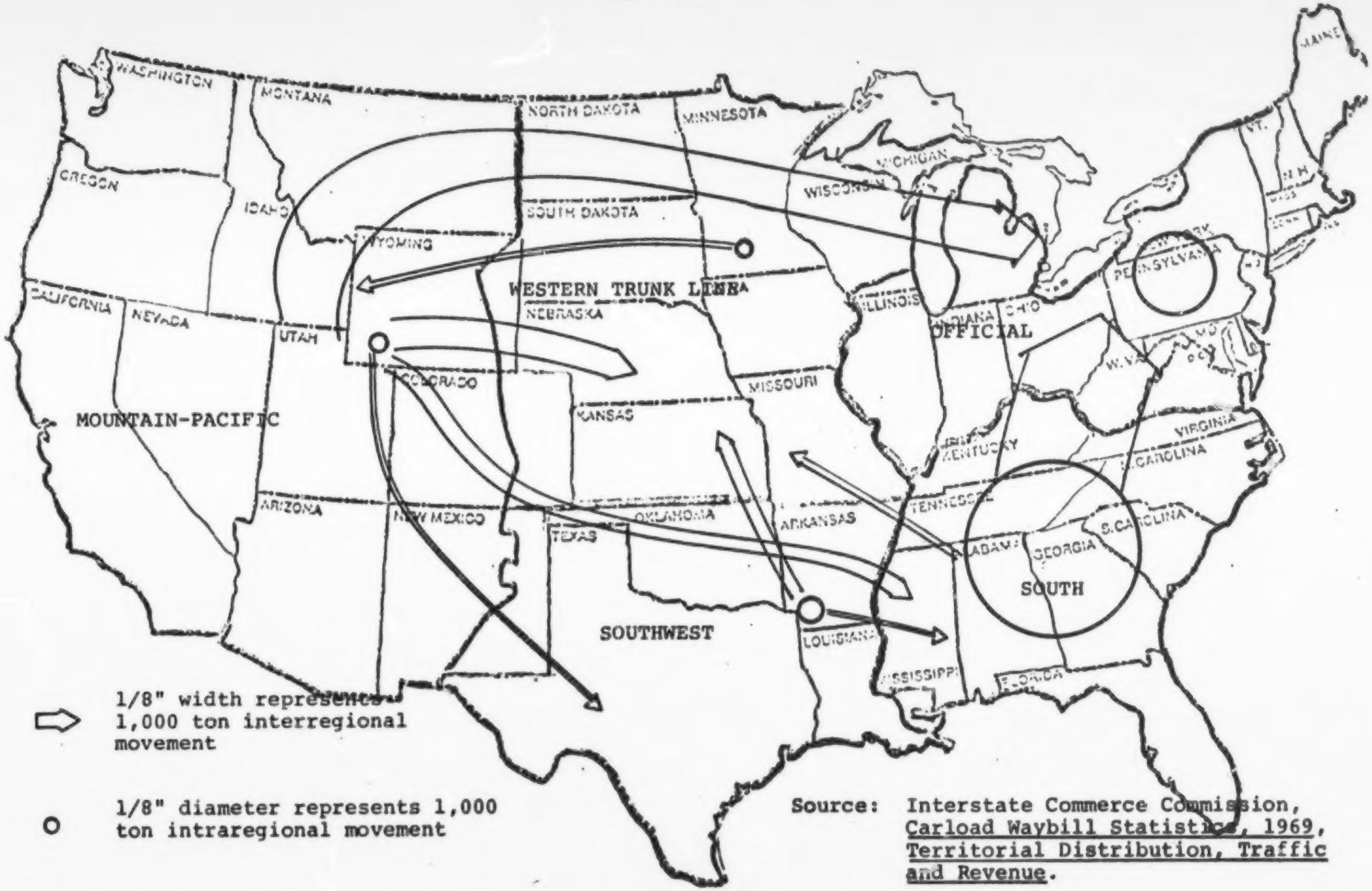
Source: Department of Transportation, Carload Waybill Statistics 1969, Territorial Distribution, Traffic and Revenue, April 1972.

Figure 4-22. Major Domestic Shipments of Wood Chips and Residue by Waterborne Carrier - 1971 (net tons)


41,880
COLUMBIA, WILLAMETTE RIVERS
348,000
SACRAMENTO RIVER
444,000
GREAT LAKES
17,300
ATLANTIC INTRACOASTAL WATERWAY
33,000
⇧ Traffic moving up river toward source
⇩ Traffic moving down river toward mouth

Source: Waterborne Commerce of the United States, Part I-V. Calendar Year 1971.

Figure 4-23. Interregional and Intraregional Rail Movements of Pulp - 1969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TENNESSEE
S. CAROLINA
ALABAMA
GEORGIA
SOUTH
SOUTHWEST
LOUISIANA
MISSISSIPPI
FLORIDA

⇨ 1/8" width represents 1,000 ton interregional movement

○ 1/8" diameter represents 1,000 ton intraregional movement

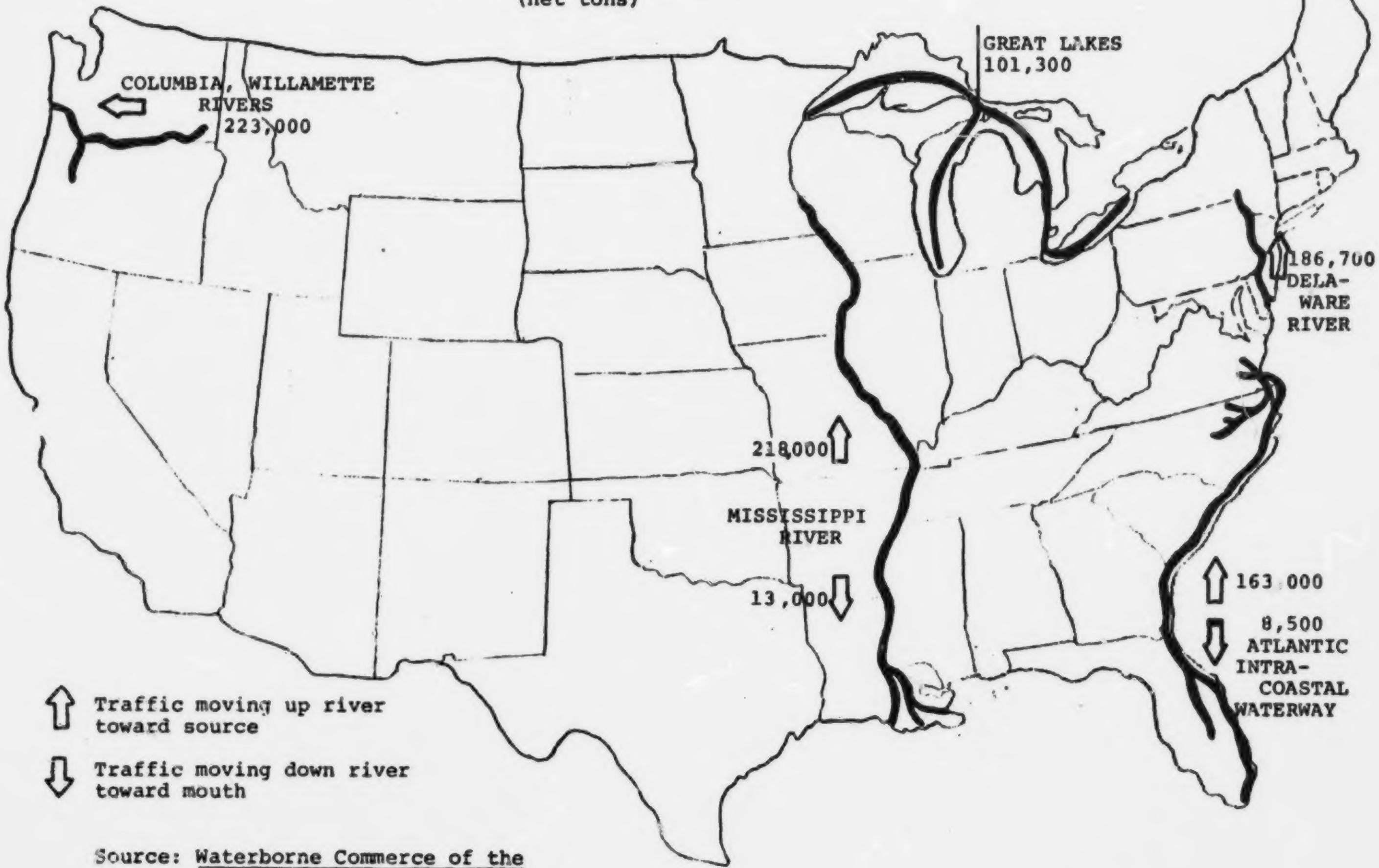
Source: Interstate Commerce Commission, Carload Waybill Statistics, 1969, Territorial Distribution, Traffic and Revenue.

Table 4-15. INTERREGIONAL AND INTRAREGIONAL RAIL MOVEMENTS OF PULP-1969

Territorial movement	Number of tons
Official to Official	6,922
Southern to Southern	11,510
Southern to Official	8,761
Southern to Western Trunk Line	574
Western Trunk Line to Western Trunk Line	1,428
Western Trunk Line to Mountain Pacific	417
Southwestern to Southwestern	2,118
Southwestern to Official	1,948
Southwestern to Southern	482
Southwestern to Western Trunk Line	660
Mountain Pacific to Mountain Pacific	1,653
Mountain Pacific to Official	3,962
Mountain Pacific to Southern	907
Mountain Pacific to Western Trunk Line	1,868
Mountain Pacific to Southwestern	301

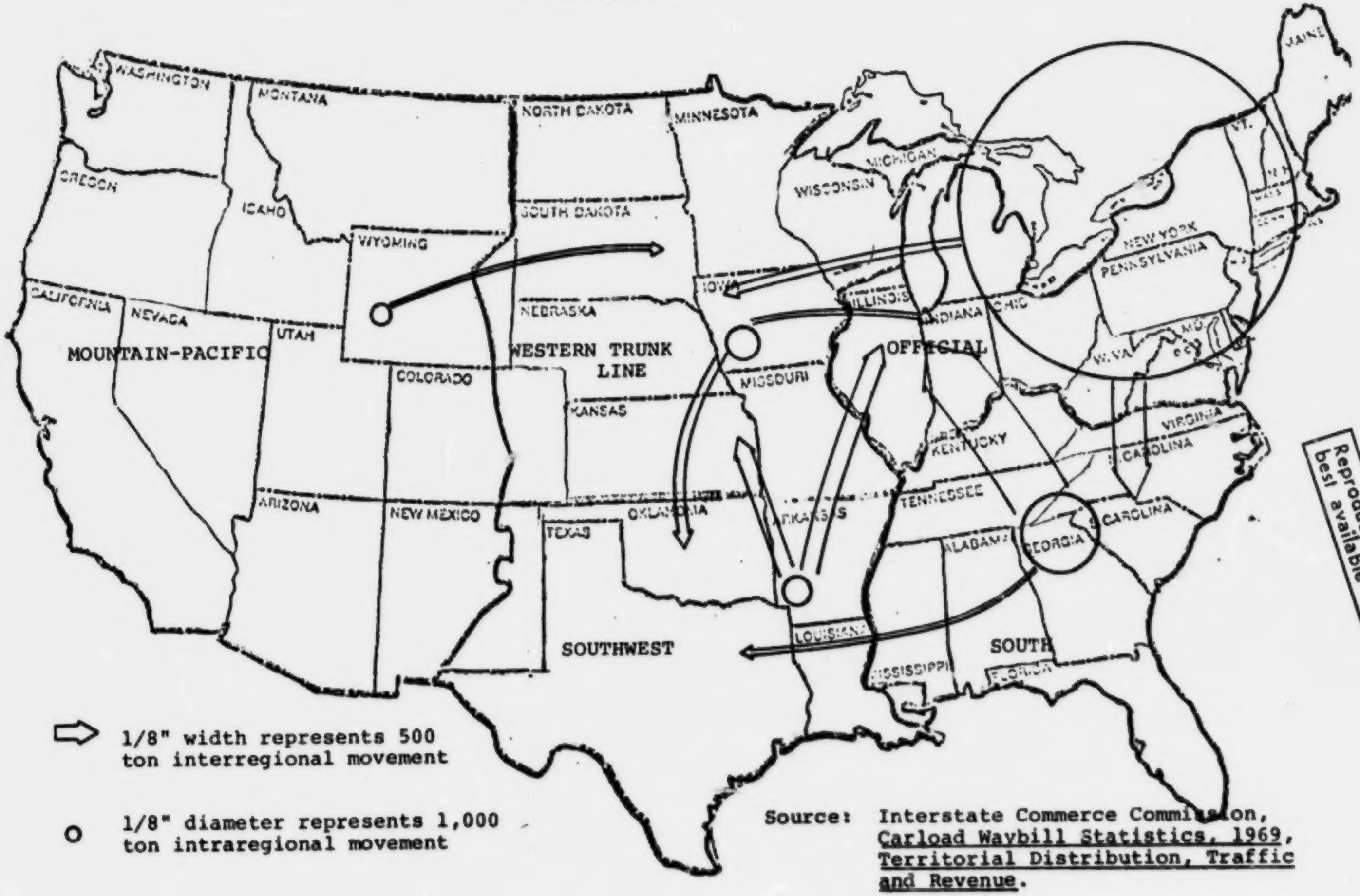
Source: Department of Transportation, Carload Waybill Statistics 1969, Territorial Distribution, Traffic and Revenue, April 1972.

Figure 4-24. Major Domestic Shipments of Wood Pulp
By Waterborne Carrier-1971
(net tons)


COLUMBIA, WILLAMETTE RIVERS
223,000
GREAT LAKES
101,300
186,700
DELA-WARE RIVER
218,000
MISSISSIPPI RIVER
13,000
163,000
8,500
ATLANTIC INTRA-COASTAL WATERWAY
⇧ Traffic moving up river toward source
⇩ Traffic moving down river toward mouth

Source: Waterborne Commerce of the United States, Part I-V. Calendar Year 1971.

Figure 4-25. Interregional and Intraregional Rail Movements of Wastepaper - 1969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LOUISIANA
MISSISSIPPI
FLORIDA
SOUTHWEST
SOUTH

⇨ 1/8" width represents 500 ton interregional movement

○ 1/8" diameter represents 1,000 ton intraregional movement

Source: Interstate Commerce Commission, Carload Waybill Statistics, 1969, Territorial Distribution, Traffic and Revenue.

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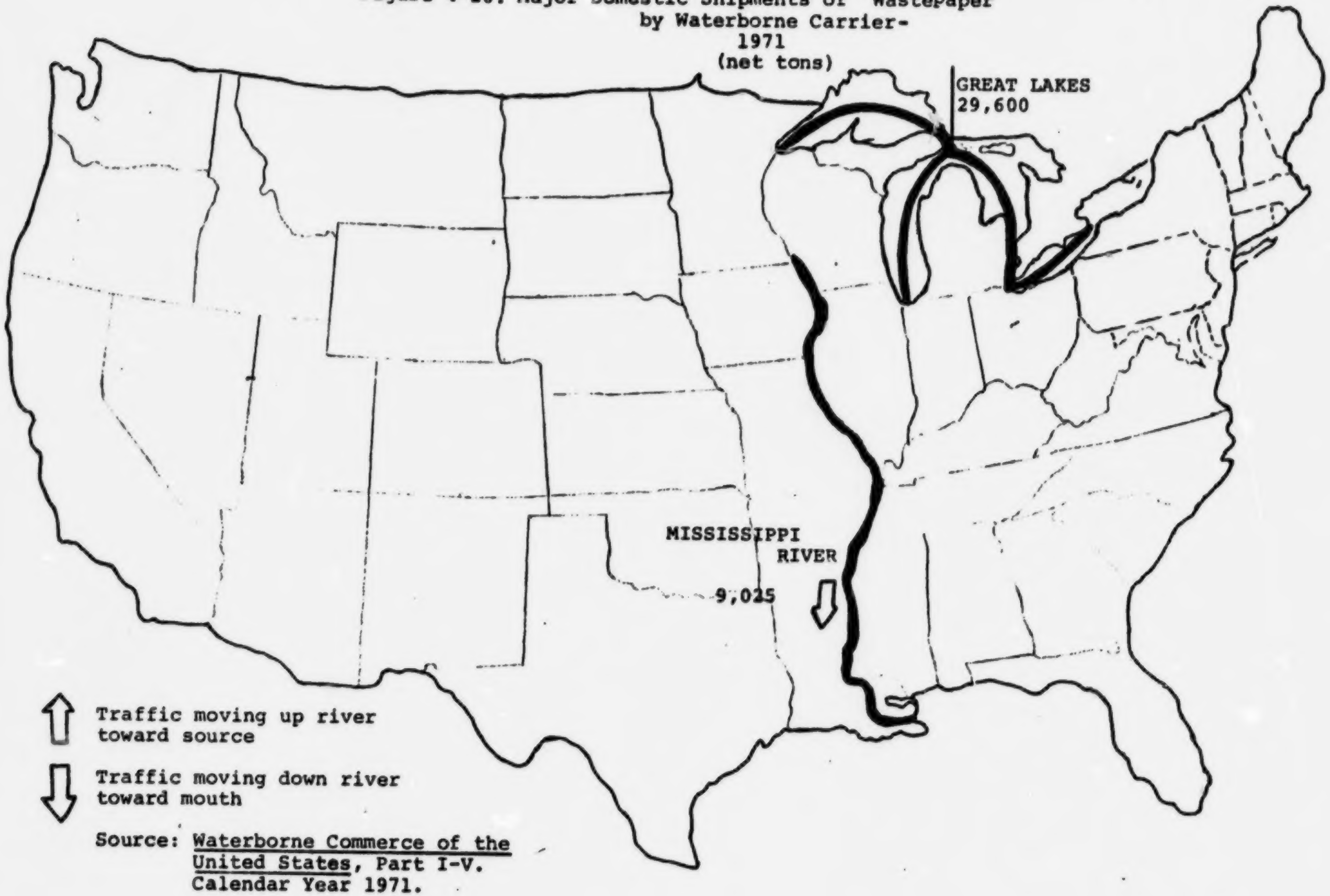
Table 4-16. INTERREGIONAL AND INTRAREGIONAL RAIL MOVEMENTS OF WASTEPAPER -1969

Territorial movement	Number of tons
Official to Official	18,040
Official to Southern	996
Official to Western Trunk Line	386
Southern to Southern	6,037
Southern to Official	2,277
Southern to Southwestern	258
Western Trunk Line to Western Trunk Line	3,512
Western Trunk Line to Official	388
Western Trunk Line to Southwestern	403
Southwestern to Southwestern	2,908
Southwestern to Official	552
Southwestern to Western Trunk Line	539
Mountain Pacific to Mountain Pacific	1,920
Mountain Pacific to Western Trunk Line	272

Source: Department of Transportation, Carload Waybill Statistics 1969, Territorial Distribution, Traffic and Revenue, April 1972.

Figure 4-26. Major Domestic Shipments of WastePaper
by Waterborne Carrier-
1971
(net tons)


GREAT LAKES
29,600
MISSISSIPPI
RIVER
9,025
⇧ Traffic moving up river toward source
⇩ Traffic moving down river toward mouth

Source: Waterborne Commerce of the United States, Part I-V. Calendar Year 1971.

trucking movements are generally back-hauls within a 150 mile radius of the consuming mill. This range and the mill concentrations shown in Figure 4-18 (p. 79) would indicate that most of the wastepaper movement by truck is within the North Central and Northeastern states.

A distance of 150 miles is the maximum for using trucks to transport raw materials for paper. Beyond this distance, the flexibility and low terminal costs of trucks are not high enough to outweigh the low line-haul costs of railroads and barges. Average distances for the 1969 rail movements of these materials are shown in Table 4-17 (p. 77). Virgin raw materials, roundwood and residues, move relatively short distances from forests to nearby pulp mills. Pulp, however, travels significant distances because of the large proportion of interregional movements between the pulp producing areas of the South and West and the market pulp consumption areas. Wastepaper also moves considerable distances by rail since trucks are used for most of the short hauls. The differences shown in the table are the differences between either roundwood, residues or pulp and the movement of wastepaper. These comparisons suggest the potential rail cost differentials resulting from distance differences for transporting virgin and secondary raw materials. Information on the distances which inland water carriers move the commodity are not available.

Table 4-17. AVERAGE RAIL HAUL DISTANCE FOR VIRGIN AND SECONDARY PAPER-MAKING MATERIALS - 1969

		Average rail haul distance (short haul miles)						
		Virgin materials			Secondary material	Differences *		
	Movement	Round-wood	Wood chips & residues	Pulp	Waste paper	Roundwood basis	Wood chip basis	Pulp basis
	Nationwide (US to US)	133	160	883	365	232	205	518
Region	Official (Off to Off)	155	158	295	236	81	78	59
	Southern (Sou to Sou)	123	109	322	270	147	161	52
	Western Trunk Line (Wtl to Wtl)	221	419	96	319	98	100	223
	Southwestern (Sw to Sw)	127	102	115	278	151	176	163
	Mountain-Pacific (Mtp to Mtp)	108	193	502	402	294	209	100

Source: Office of Systems Analysis and Information, Department of Transportation, *Carload Waybill Statistics 1969, Territorial Distribution, Traffic and Revenue by Commodity Classes*, April 1972.

* positive sign shows the virgin material moves farther.

INSTITUTIONAL CHARACTERISTICS

In order to gain some insight into transportation costs and to understand some of the transportation statistics and terminology, it is helpful to look at how the Interstate Commerce Commission (ICC) influences transportation system characteristics. The Commission is the major Federal institution involved in regulating the various transportation modes and plays a significant role in establishing interstate rates and in determining which companies will be allowed to carry which commodities. State agencies can also influence transportation costs by establishing load limits, safety regulations and intrastate rates, but these factors usually only affect local conditions. Two examples of state agency influence are Oregon's practice of letting railroads establish contract rates for intrastate hauls and California's regulations which allow truckers to set rates equal to comparable railroad movements. However, the scope of this report does not permit these local influences to be studied thoroughly. In this study, the ICC stands as the major institutional influence.

The Role of the Interstate Commerce Commission

In order to gain a perspective on the influence which the ICC exerts on the three transportation modes, it is necessary to review what the Commission sees as its objectives and how its behavior has conformed to this view. The ICC's original mandate, established in the 1880's, was to maintain a viable railroad system. The National Motor Carrier Act of 1935 and subsequent legislation extended this role to include motor carriers and inland water carriers. As mandated by these laws, the Commission has continued to view its role as primarily a guardian of the transportation system's welfare. W. D. Brewer, an ICC Commissioner, has summarized the Commission's view of its roles as follows:

> While we on the ICC must be aware of the need to transport your products at a profit, we must also recognize our responsibility in maintaining a viable, economical and healthy transportation system.[15]

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[15] Brewer, W. D., "Transportation Problems on Scrap", *Waste Trade Journal*, March 31, 1972, p. 11.

This statement articulates the tradeoff which the Commission must often make in its decisions; between transportation system interests and other economic and societal interests. Traditionally, the Commission's rulings have weighed transportation issues much more heavily than any other issues which may be relevant to a given case. D. P. Locklin, a transportation scholar, made the following observations on the Commission's treatment of social problems which may be influenced by their decisions:

> The Commission admonished the carriers to lower their rates on wastepaper with the observation that the utilization of waste material is of economic value to this country--Reduced Rates, 1922, 68ICC-676.
>
> Although public welfare and social good have apparently been considered in cases like those mentioned, these considerations may not after all have been given much weight. In fact, to allow considerations of public policy and welfare to influence a rate case is wholly inconsistent with the common pronouncement of the Commission that the reasonableness of rates on particular articles is to be determined by their transportation characteristics.[16]

It is understandable, then, that environmental strategies which aim to change transportation costs not for better transportation, but rather, to encourage recycling, meet with limited interest from the Commission. If rate changes are to remain a component of environmental strategies, they must be presented in a manner which emphasizes the "transportation characteristics" of the commodities or else they must be designed to avoid involving the ICC in the proposed changes.

In its day-to-day operations the ICC regulates most carriers who transport interstate commerce. In 1970, nearly 100 percent of railroad shipments, 40 percent of motor carrier shipments and 10 percent of inland water commerce moved under the jurisdiction of the Commission.[17]

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[16] Locklin, D. P., Economics of Transportation, 6th edition, Richard D. Irwin, Inc., 1966.

[17] "Now: Traffic Jams on U.S. Rivers," U.S. News and World Report, September 20, 1971, p. 66.

Rate Setting and Regulation - Rail

Since nearly all railroads are regulated by the ICC, and since the growth of new railroads is insignificant, the Commission's primary influence on rail transportation costs result from its influence on rate changes. All railroad rates are established by the common carrier concept. Under the common carrier principle, regulated transportation companies must carry people or goods or both at published fares on set schedules. Railroads, trucking companies and other transportation companies must serve both profitable and unprofitable markets. High-profit operations within each carrier have always been expected to subsidize the uneconomic but socially necessary services--a concept called cross-subsidization. In return for agreeing to haul anyone or anything correctly tendered to them under their franchise, common carriers get rate and route protection from the ICC and stay free of government ownership.[18]

The railroad rate structure which has evolved under the common carrier concept is one of the most complex systems operative in this country. The system started in the 1880's by grouping all commodities into classes of similar transportation characteristics and setting rates for each class. In general, these rates followed a mileage scale and were relatively simple to compute. But the growth in the number of commodities and the number of shipping points generated a need for many specific rates to apply to the various transportation situations. This changing situation resulted in the establishment of a new classification system in 1933. The new system contained 30 classes, 7 classes above class 100, and 22 classes below class 100. Class 100 is a reference associated with a specific dollar per ton rate. The carriers have subsequently added class 110 bringing the total number of classes to 31.

The railroads, however, continued to publish "exceptions" to the class rates to provide for special situations not taken into account by the existing rate structure. The railroads also publish commodity rates. A commodity rate is a rate quoted on an article directly instead of through the medium of a system of freight classifications. Commodity rates may consist of special point-to-point rates, built upon no systematic basis, but adjusted to meet the needs of some particular shippers or communities as a response to certain competitive situations.

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[18] Locklin, Economics of Transportation.

As a result of this structure, high volume users can negotiate rates to meet their needs and their special conditions. Other commodity rates are more extensive in character and may cover all important movements of a particular commodity. Today over 90 percent of railroad shipments are made under a commodity rate; the remainder are made under class or exception rates.[19] The maze of commodity rates is extremely difficult to understand and makes the comparison of railroad transportation rates very difficult. Consequently, this study compared virgin and secondary transportation rates by aggregating revenues and comparing average revenues per ton of the commodity shipped.

The rate-making or rate-changing processes are legalistic, complex and extremely slow. The power to make and change rates rests initially with the railroad companies. The companies can increase rates individually or they can combine to request general or "ex parte" increases covering all the railroads in one of the five rate-making regions or in the entire nation. Usually the carriers in a given area act through freight associations or bureaus in making changes.

Shippers or interested parties seeking rate changes normally bring their proposals before the individual railroads or before the appropriate rate bureaus. If satisfactory adjustments are not obtained in this way, resort may be made to the ICC or to state regulatory authorities, provided there are grounds for believing that the rates are unreasonable or otherwise unlawful.

A recent article in Fortune described the rate changing process as follows:

> Legal obstructionism is so automatic and so unthinking that railroads will oppose almost any pricing change by anyone....The railroads continually squabble over how to divide the revenue on freight that travels over several lines....They argue these disputes

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[19] Locklin, Economics of Transportation.

> in time-consuming judicial hearings before the ICC, which has no machinery for compulsory arbitration. This ponderous procedure, coupled with the railroads' own fragmentation, discourages most railroads from seeking long-haul business that they might otherwise handle and a lot of that traffic ends up on trucks.[20]

The usual method of determining the reasonableness of rates on a particular commodity is to compare that rate with the rate on commodities which have similar transportation characteristics. Analogous articles should ordinarily take the same rate. "Analogous articles" refers to articles that are alike from a transportation standpoint, that is, alike in the material cost of transportation and value.

Since most shippers and, in particular, secondary materials shippers are trying to get their rates as near to the lowest cost as possible, it is interesting to look at the transportation factors which the ICC uses in establishing these costs. The following outlines these factors:

- Density and compactness of loading;
- Perishability;
- Susceptibility to damage;
- Liability to damage of commodities;
- Amount of carrier liability for theft;
- Liability of spontaneous combustion or explosion;
- Volume of movement and influence of volume on direct costs;
- Value of commodity;
- Regularity of movement;
- Ease of loading and unloading;

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[20] Loving, R., Jr., "Getting the Eastern Railroads Back on the Track," Fortune, December, 1972, p. 105-108.

- Type of equipment required;
- Special resources required;
- Stowability;
- Excess weight and excess length.

The aggregated differences in these factors will generally determine the lowest railroad rates which can be established for virgin and secondary materials without subsidizing one or the other.

Rate Setting and Regulation - Motor Carrier

Common motor carriers are regulated in a manner similar to that of the railroads. The common motor carrier rate structure has been designed around the railroad rate structure and corresponds to it closely. The motor carriers have fewer classes (five compared to thirty-one rail classes), and more regional rate bureaus (twelve compared to five), but the majority of their business is also done under commodity rates established on an individual basis. Again, it should be noted that the corporate user places emphasis on management of his transportation costs. The cross-subsidization of the common carrier concept and the ICC's slow response to rate changes has affected motor carriers as well as railroads because of the inflationary cost increases they have had to absorb. Wage increases negotiated by the Teamsters Union and operating cost increases have put pressure on truckers' profits. However, the motor carriers have an inherent advantage over the railroads because they do not have to maintain and pay taxes on their right-of-way which is the national highway system. The latter advantage is somewhat mitigated by gasoline users' taxes but it still is a plus for the truckers.

Rate changes for common motor carriers are established through a procedure similar to that used to change railroad rates. The basis for determining motor carrier rates is an ICC formula which is pegged to the trucker's operating ratio.[21] The Commission usually sets the desired ratio at about .93 and seeks to maintain this level for the average trucker. Because of truckers' relatively low capital costs, a ratio of .98 corresponds roughly to a 10 percent return-on-capital. But as has been observed:

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[21] The operating ratio is the ratio of all costs except taxes and interest to total revenue.

> It [the desired ratio] does not include significant costs such as income taxes and interest on capital indebtedness, so it does not measure true financial stability as return on investment or on an equity basis. However, both the industry (trucking) and the ICC are hard put to come up with a better yardstick.[22]

Under this formula the ICC can establish maximum and minimum rates. The Commission also controls entrance into the ranks of the common truckers by issuing certificates of necessity. These certificates are issued if the Commission deems the requesting carrier's service consistent with competitive conditions. This latter requirement is important in gaining a common carrier certificate because one of the Commission's prime objectives is to prevent ruinous competition in the motor carrier industry.

The ICC also regulates interstate contract motor carriers by issuing permits and having the power to establish minimum rates. The contract motor carrier is distinguished from the common carrier in that he serves only a limited number of customers, usually less than seven. The contract carriers operate generally at a cost advantage over the common carriers. Common carriers face several disadvantages:

- shippers' traffic is generally homogeneous and moves in high volume between a few points;
- "peddle run" service calls for multiple pickups and/or deliveries;
- shipments are tendered exclusively in truckload lots;
- commodities shipped require careful in-transit segregation; and,
- rate anomalies produce disparate charges on certain movements.

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[22] "Truckers fight for a New Rate Base", Business Week, November 14, 1972, p. 68-76.

The common carrier must affirmatively support its application for a certificate with evidence of public need for its service. The contract carrier needs only to demonstrate that its operations will not conflict with the public interest. This regulation generally makes for easier entry into the ranks of the contract carriers. Once a contract permit is issued, however, the carrier's flexibility is quite limited because he is dedicating his resources to a small group of shippers. Often this inflexibility prevents the carrier from obtaining full utilization of his equipment on potential back-hauls. This can be a problem in the movement of wastepaper.

Private motor carriers (PMC) are not regulated by the ICC. The most influential institutional interests for the PMC's are the state agencies which establish load limits, safety regulations and the number of trailers which can be pulled by a single tractor. As Bergen and Barnett, two transportation experts, have written, owning a truck fleet can save a shipper the profit margin associated with contract carriage:

> The difference between private and contract carriage to the shipper is thus largely the profit margin that the contract carrier tacks on top of its actual expenses. As with most things, "do-it-yourself" is usually cheaper; the shipper must be willing to pay for being relieved of the aggravation of private carriage.[23]

Private ownership of trucks can also relieve the shipper of involvement with the ICC. Contract carriers often use the services of the shipper in ICC hearings to obtain permits and rate changes.

The primary reason for the switch to private motor transport, however, is management's desire to control all the resources which are important in its operations. By controlling the trucks, management is able to reduce some of the variability in transport costs and reduce uncertainty in operations. As Oi has noted,"...vertical integration (i.e., into trucks) is equivalent to a reduction in the variance of profits; integration is neutral with respect to expected profits."[24] An additional incentive to the development of private motor fleets lies in the relatively small economies of scale associated with trucking operations. Warner's study[25] suggests that small trucking fleets can realize costs that are comparable to those of the largest common carriers. Although some economies of scale are found, these generally are attributable to more efficient scheduling which results in high load factors.

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[23] Bergen, B.P. and Barnett, Colin, The Elements of Contract Carriage: The Traffic Service Corp., Washington, D.C., 1972.

[24] Oi, W.Y. and Hurter, A.P., Jr., Economics of Private Truck Transportation: William C. Brown Co., Inc., 1965.

Rate Setting and Regulation - Water Carrier

The inland water carrier business is relatively free of regulation. Barge operators often negotiate deals by telephone. Decisions on cargos often turn on less than one cent per ton. Bulk commodities, such as coal, limestone, wood chips and roundwood, are not subject to ICC control when moving by water, but the rates of all the other commodities mentioned in this study do fall under the watchful eye of the ICC.

The process which the ICC uses to change the rates for inland water carriers is nearly identical to the process used in rail rate changes. The classification of carriers is the same as for the motor carriers and the procedure for entering the industry is similar. Technological changes and the improvement in waterways have pushed charges for waterborne freight below those that existed in 1960 and considerably lower than for any other form of transport: "For one dollar, a ton of freight moves 330 miles by barge, compared with 70 miles by railroad and 14 miles by truck."[26]

Barge prices have stayed low because operators have kept their costs low compared to the railroads who are their chief competitors. There have been no serious labor problems for barge operators. Wage increases have had little impact on profits because the industry is so capital-intensive--about $80,000 of capital is invested per employee compared with $50,000 for railroads.[27]

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[25] Warner, Stanley L., "Cost Models, Measurement, Errors and Economies of Scale in Trucking." An unpublished manuscript, Transportation Center, Northwestern University.

[26] "Now: Traffic Jams on U.S. Rivers." U.S. News and World Report, September 20, 1971, p. 66-68.

[27] "Teacher's Pet - While the rails languish, airlines suffer and truckers hurt, the barge lines are doing great," Forbes, March, 1971, p. 50.

In addition, the technology has advanced to the point where tug boats can now move as many as 50 barges covering about 7 1/2 acres of river and carrying the equivalent of 500 carloads of coal.

Barges have another advantage in that they are exempt from waterway taxes. Nor do the barge companies pay for waterway improvements; locks, dams and channels are all built, maintained and operated by the U.S. Army Corps of Engineers with no charge to shippers. This association with the Corps is an important institutional tie which is aiding inland water carrier growth.

V. ANALYSIS OF TRANSPORTATION COSTS OF RAW MATERIALS

Chapter V presents the transportation cost data collected during this study and the results of subsequent analysis. An outline of the analytic methodology and a brief description of the data have been presented in Chapter III. This chapter provides a more detailed discussion of:

- the specific analytic techniques and data used in the study;
- the difference between virgin and secondary material transportation costs;
- the ratio of transportation costs to production costs;
- the difference between average revenue and the carriers' costs of transporting virgin and secondary paper and steel raw materials;
- the results of a regression analysis on the influence of transportation in secondary material usage.

ANALYTIC TECHNIQUES

General Methodology

Three comparisons have been employed in determining the extent to which transportation costs influence the recycling of wastepaper and scrap iron and steel. These comparisons are the fundamental analytic techniques of the study.

The first compares the cost difference between transporting secondary material to a secondary production facility and transporting the equivalent virgin material to a virgin (i.e., integrated) production facility. The empirical results of this comparison show the transportation cost differentials which the paper and steel industries must consider in their decision to use virgin or secondary materials. It is assumed that the usage of secondary material by an industry is influenced by the differences in cost illustrated by the comparison.

The second comparison presents the raw materials transportation costs as a proportion of production costs. This proportion relates the importance of raw materials transportation costs to other costs which enter the investment decision. The magnitude of the difference in costs for moving virgin and secondary materials may be large relative to transportation costs. However, if transportation costs are small relative to production costs, then the importance of the transportation cost differential in the investment decision will be minor compared to other factors.

A third, although less important, comparison was made to determine the carriers' ability to reduce transportation rates. The carriers' costs of transporting virgin and secondary materials were compared to revenues to ascertain the variance between the carriers' out-of-pocket costs and their revenues. This variance indicates the amount by which rates might be reduced without causing the carriers to lose money or reduce service on a specific commodity.

Comparison 1: The Difference Between Virgin and Secondary Materials Transportation Costs

- Virgin and secondary raw material transportation cost differences have been calculated in two types of comparisons. The first is a direct comparison of the cost of moving equal amounts of the raw materials used for iron units in steel production or fiber units in paper and board production. In the case of steel, the comparison is made of moving one ton of iron ore versus moving one ton of scrap iron and steel. In the case of paper, the comparison is made of moving one ton of roundwood or wood chips versus moving one ton of wastepaper. These direct comparisons neglect differences in the required proportion of the virgin and secondary materials necessary to produce an equivalent unit of output. Also neglected are supplementary materials, such as coke, essential in the production of the finished products whether the major element is virgin or secondary material. The direct comparisons do illustrate, however, the cost of moving the major elements in the production of steel or paper, a comparative basis consistent with industry practice. The cost of moving one ton of wood pulp was also compared directly with the cost of moving a ton of wastepaper to assess the tradeoffs which some non-integrated paper and board mills face.

Most investment decisions are made on the basis of cost differentials for moving all the raw materials necessary to produce a unit of the final product. The second type of comparison is based, therefore, on the difference in costs for moving the necessary proportions of virgin and secondary materials to make a given amount of final product. This difference is termed a chemically-adjusted comparison. For instance, in the making of steel, it is necessary to use a certain amount of coal, limestone and iron ore to produce steel in an integrated facility; alternatively, an equivalent amount of purchased scrap is required to produce steel in an electric furnace. In order to decide rationally whether to invest in a plant using one of the competing raw materials, the steel executive must consider the difference in the cost of moving all the equivalent amounts of virgin or secondary materials to produce a unit of output.

Both the direct and chemically-adjusted comparisons have been made on an intramodal basis. This has eliminated the need for arbitrary assumptions about the transportation modes to be used for each commodity since most of those companies interviewed will strive for unimodal movements to reduce the complexity of multi-mode service. The intramodal comparison highlights biases which may exist in the rate structure of a given mode.

Two distinct problems relating to the availability and quality of data have surfaced as a result of the use of the two types of cost comparisons defined above. The first relates to establishing the proper virgin and secondary material proportions to be used in the chemically-adjusted comparisons; the second involves the actual data to be used for the cost of moving the commodities by the various modes.

However, chemical adjustments for paper-making raw materials were determined based on data supplied by the Traffic Committee of the American Paper Institute (API). These data were established for making one ton of average thickness corrugating medium from either virgin or secondary materials. The API suggested that 2.38 tons of roundwood or 3.67 tons of wood chips or 1.0 ton of pulp or 1.1 tons of wastepaper would be required to produce the representative ton of medium. By multiplying these amounts with the average costs for transporting one ton of these materials and comparing the virgin and secondary alternatives, chemically-adjusted cost differentials were obtained for the equivalent raw materials necessary to produce one ton of corrugating medium.

The equivalency ratios for steel production were acquired from data published by the American Iron and Steel Institute. These data showed that an average ton of steel requires 1.585 tons of iron ore, .242 tons of limestone and .912 tons of coal for production from virgin materials. If coke is transported to the blast furnace, then .648 tons of coke should be substituted for the coal. The electric furnace would require a charge of approximately 1.0 tons of scrap to produce the equivalent amount of steel.[1]

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[1] It should be noted that the equivalencies established in this study differ significantly from similar numbers used by Battelle in the ISIS study. Discussions with steel industry consultants and technical experts have indicated that the ISIS equivalencies are not representative. The ISIS completely neglected limestone on the basis of their assumptions that only a small amount of limestone moves by rail and that the total cost of moving the limestone is very low. However, interviews with steel industry experts and transportation companies (rail, truck and barge), as well as data from the one percent Waybill Sample for railroads have indicated that the cost and amount of limestone shipments are significant enough for inclusion in unimodal comparisons. The ISIS study also used significantly less than the .912 tons of coal

The equivalent amounts of virgin material were multiplied by the cost of moving one ton of the material, summed for the three materials and subtracted from the cost of moving a ton of scrap to calculate the chemically-adjusted transportation difference for steel.

The second problem, choosing the actual data to be used in the cost comparisons, is discussed in detail in Chapter III.

Comparison 2: The Ratio of Transportation Cost to Production Cost

The ratio of transportation costs to production costs has been used to substantiate the importance of transportation costs in the investment decision process. The ratio was derived by two different methods for the steel and paper industries. The use of these methods was dictated by the availability of data on production costs for the two industries.

The ratio of steel transportation and production costs was established by dividing the transportation rates calculated on the chemically-adjusted basis by the average production cost for a ton of steel.[2] For

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[1] (continued) or the .648 tons of coke necessary to make a ton of steel from virgin components in its comparison. This reduction was made on the assumption that an amount of coal equivalent to the subtracted coal or coke is required to heat the scrap to a molten state equivalent to hot metal. Conversations with metallurgists have shown this assumption to be overly simplistic since there are multiple heat sources in the blast furnace, and the heating value of coal is used in many chemical reactions other than the melting of the metal. Thus, this study has not reduced the coal proportion since a metallurgical analysis beyond the scope of this study would be required to determine the proper ratio. Once established, this ratio would probably not change the .912 tons of coal significantly.

[2] Production cost information was obtained from Edwin F. Brush III, Ph.D., Metallurgical Consultant; Professor Merton Flemings, Professor of Metallurgy, MIT.

example, the average transportation costs for moving the necessary amounts of iron ore, coal and limestone were determined and summed to give an estimate of the total transportation costs for moving the virgin materials to an integrated facility. This sum was then divided by the average production cost for a ton of steel produced in a BOF and electric furnace. This method of calculating the ratio was relatively simple and the results should be representative of industry averages.

The ratio of raw material transportation to production cost in the paper industry was obtained from a 1967 survey conducted by the API. The survey did not include the distribution of the ratio among firms but it provided representative data on the average ratio for the industry. The age of the survey does cause some concern, but discussions with paper industry experts indicate that the relationships have not changed significantly since 1967.

Comparison 3: The Difference Between Average Revenues and the Carriers' Costs of Transporting Virgin and Secondary Paper and Steel Raw Materials

The carriers' costs for moving the commodities were established on the basis of Standard ICC Rail Form A and Highway Form B costs. Both of these costs are derived from standard costing formulas developed by the ICC from empirical data collected over many years. The cost of moving steel-making raw materials was developed only for railroads because of the relative unimportance of motor carrier shipment of these commodities. This cost of movement by rail was taken from ICC calculations on the Department of Transportation's latest version of Rail Form A. The use of this information made it unnecessary to establish and verify a consistent set of assumptions and modifications required to make Rail Form A costs applicable to a specific commodity. Since these costs are not significant to the two primary comparisons of this study, the ICC calculations are adequate for the secondary comparisons for which the costs are used.

In the case of paper, railroad costs for shipment of wastepaper were obtained from the ICC calculations based on Rail Form A. The costs of moving wastepaper by truck were calculated from Highway Form B data. These calculations were made under the assumption that direct hauls were used to move the materials and that no intermediate terminal handling was necessary. The Highway Form B costs are based on sampled costs for moving commodities of a given density a given distance by common motor carrier.

These costs were calculated for each of three variations of density which are assumed to be representative of wastepaper loadings. It is also assumed that Highway Form B represents private and contract motor carrier, as well as common carrier, costs, due to the lack of significant economies of scale in the trucking business[3] and overall efficiency of private and contract carriers.

The Regression Analysis

The comparison of transportation costs for virgin and secondary materials and the comparison of transportation costs to production costs were used to infer the influence of transportation costs on the use of secondary materials. In order to determine if the empirical evidence detailed could be further substantiated, a linear regression analysis was conducted. This analysis was confined to steel-making raw materials because of their almost exclusive use of the railroads. It was hypothesized that since both virgin and secondary steel-making raw materials were confined to rail movement that rail rate differentials would be the primary transportation cost influence on the use of these materials. This, of course, assumed that service costs for the two commodity groups were either equal or a constant differential unchanging over the time frame of the regression. The use of multiple modes of transportation in the paper industry would have necessitated a multivariant regression involving the cost of private and contract motor carriage. The scarcity of motor carrier data precluded making such a multivariant analysis.

The regression for the steel industry established the correlation between the proportion of raw materials represented by purchased scrap iron and steel (the dependent variable) and the difference in transportation rates for scrap iron and steel and virgin raw materials (the independent variable) (see Table 5-3, p. 117). The proportion of raw materials represented by scrap was taken from ISIS data back to 1956. The two types of transportation costs differentials were used for the regression:

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[3] Warner, Stanley L., "Cost Models, Measurement, Errors and Economies of Scale in Trucking". An unpublished manuscript, Transportation Center, Northwestern University.

first, the direct comparison between iron ore and scrap; and second, the chemically-adjusted comparisons on the coal and coke basis. The scrap proportion was regressed against each rate differential to determine the amount of correlation between the two variables. In addition, two other regressions were conducted by adding time as a second independent variable in order to account for any technological changes which may have occurred since 1956 that influenced the use of scrap.

COMPARISON OF VIRGIN AND SECONDARY RAW MATERIALS TRANSPORTATION COSTS

The cost differentials for shipping virgin and secondary raw materials will be discussed in two segments. The differences in transportation rates or the quantifiable aspects of the problem will be presented first. Next, the qualitative or service aspects of the cost differentials will be reviewed. Finally, the quantified data and the qualitative descriptions will be correlated to give an overall assessment of cost differences.

Transportation Rate Differentials

Steel Raw Materials -

Tables 5-1 (p.115) and 5-2 (p.116) show the average railroad revenues per ton for moving steel-making raw materials and the direct revenue per ton differences between iron ore and scrap iron and steel in 1969 and 1970. The regional data in these tables provide some indication of the variance in the national data. Table 5-3 (p.117) presents the same type of data but without regional variations back to 1956. Class I car loading and revenue per car data is provided in Table 5-4 (p.118) for 1970.

Data in Table 5-4 (p.118) show that since 1956 ore has moved for \$1.72 per ton to \$2.85 per ton less than scrap on a nationwide average basis. However, the data in Tables 5-1 (p. 115) and 5-2 (p.116) reveal that revenues in the Eastern region favored the movement of scrap by \$1.54 per ton and \$1.15 per ton in 1969 and 1970. Average revenues for scrap are lower in the East because larger volumes of scrap move in the area. These relatively large movements, shown on the maps in Chapter IV, provide sufficient leverage for scrap dealers to negotiate the rates below the nationwide average.

Tables 5-5 (p.119) and 5-6 (p.120) show the steel raw materials chemically-adjusted rate differentials for railroads. The coal basis indicated in these tables assumes that coal is moved to the blast furnace for conversion to coke. The coke basis assumes that coke is moved to the blast furnace from distant coking ovens. On the chemically-adjusted basis, it is evident that the secondary materials are generally moving at a lower average rate. In Table 5-5 (p. 119), assuming coal is

Table 5-1. COMPARISON OF AVERAGE RAILROAD REVENUE PER TON FOR VIRGIN AND SECONDARY STEEL RAW MATERIALS - 1969

	Average railroad revenues, $/net ton					
	Virgin materials				Secondary material	Difference **
Movement	Iron ore [1]	Lime-stone* [2]	Coal [3]	Coke [4]	Scrap iron & steel [5]	Between ore and scrap [5]-[1]
Nationwide	2.26	2.42	3.12	5.29	4.37	2.11
Eastern district	5.66	2.54	3.46	4.71	4.12	-1.54
Southern district	2.32	2.66	2.44	6.29	4.28	1.96
Western district	1.29	3.23	2.51	6.90	5.05	3.76

* Limestone data from Carload Waybill Statistics 1969.
** negative sign shows lower rate for secondary material.

Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Railroads, 1969.

Note: See Appendix E for definition of districts.

Table 5-2. COMPARISON OF AVERAGE RAILROAD REVENUE PER TON FOR VIRGIN AND SECONDARY STEEL RAW MATERIALS - 1970

Movement	Average railroad revenues, $/net ton					
	Virgin materials				Secondary material	Difference **
	Iron ore [1]	Lime-stone [2]	Coal [3]	Coke [4]	Scrap iron & steel [5]	Between ore and scrap [5]-[1]
Nationwide	2.31	2.47	3.43	5.53	4.83	2.52
Eastern district	5.63	2.57	3.85	5.01	4.48	-1.15
Southern district	2.42	2.76	2.63	5.77	4.81	2.39
Western district	1.35	3.29	2.87	9.94	5.60	4.25

* Limestone data from Carload Waybill Statistics 1969 adjusted for 1970 comparable to iron ore 1969-1970 increase from Freight Commodity Statistics.

** negative sign shows lower rate for secondary material.

Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Railroads, 1970.

Table 5-3. COMPARISON OF NATIONWIDE CLASS I RAILROAD REVENUE FOR VIRGIN AND SECONDARY STEEL RAW MATERIALS
($/ton)

Year	Virgin materials				Secondary material	Difference between ore and scrap
	Iron ore	Metallurgical coal	Coke	Pig iron	Scrap iron and steel	
1956	2.07	3.45	3.56	4.52	4.03	1.96
1957	2.19	3.57	3.70	5.38	4.18	1.99
1958	--	--	--	--	--	--
1959	2.44	3.48	4.15	2.74	4.42	1.98
1960	2.34	3.40	4.08	5.17	4.06	1.72
1961	2.24	3.52	4.16	4.19	4.19	1.95
1962	2.13	3.31	4.08	5.04	4.08	1.95
1963	2.25	3.21	4.32	4.60	4.12	1.87
1964	2.25	3.13	4.43	4.54	4.15	1.90
1965	2.28	3.13	4.52	4.39	4.20	1.92
1966	2.18	3.01	4.36	4.49	4.20	2.02
1967	2.20	3.01	4.59	4.41	4.33	2.13
1968	2.24	3.02	4.75	4.37	4.31	2.07
1969	2.26	3.12	5.29	3.94	4.37	2.11
1970	2.31	3.43	5.53	4.01	4.83	2.52
1971	2.63	3.73	6.47	4.64	5.48	2.85

Source: Interstate Commerce Commission, Freight Commodity Statistics Class I Railroads, years 1956-1957, 1959-1971.

Table 5-4. CLASS I RAILROAD REVENUE AND LOADING DATA FOR VIRGIN AND SECONDARY STEEL RAW MATERIALS - 1970

Movement	Statistics	Average railroad revenue and loading statistics					
		Virgin material					Secondary material
		Iron ore	Metallurgical coal	Coke	Fluxing limestone	Pig iron	Scrap iron & steel
Nationwide	Tons/carload	77.4	76.6	43.8	NA	92.2	54.2
	$/carload	179.0	263.0	242.0	NA	370.0	262.0
	$/ton	2.31	3.43	5.53	NA	4.01	4.83
Eastern district	Tons/carload	79.0	74.8	42.9	NA	107.7	56.0
	$/carload	445.0	288.0	215.0	NA	406.0	251.0
	$/ton	5.63	3.85	5.01	NA	3.77	4.48
Southern district	Tons/carload	82.4	79.2	46.1	NA	67.4	51.3
	$/carload	199.0	208.0	266.0	NA	229.0	247.0
	$/ton	2.42	2.63	5.77	NA	3.40	4.81
Western district	Tons/carload	76.8	81.9	49.0	NA	71.9	51.8
	$/carload	104.0	235.0	487.0	NA	448.0	290.0
	$/ton	1.35	2.87	9.94	NA	6.23	5.6

Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Railroads, 1970.

Table 5-5. COMPARISON OF AVERAGE RAILROAD REVENUE PER TON FOR VIRGIN AND SECONDARY STEEL RAW MATERIALS - 1970
Chemically-Adjusted Basis

Movement	Average railroad revenues, $/net ton of steel								
	Virgin materials						Secondary materials	Differences**	
	Iron ore (1.585) [1]	Lime-stone (.242)* [2]	Coal (.912) [3]	Coke (.648) [4]	Total coal basis [1]+[2]+[3] [5]	Total coke basis [1]+[2]+[4] [6]	Scrap iron & steel (1) [7]	Coal basis [7]-[5]	Coke basis [7]-[6]
Nationwide	3.66	.55	3.13	3.58	7.34	7.79	4.83	-2.51	-2.96
Eastern district	8.92	.61	3.51	3.25	13.04	12.78	4.48	-8.56	-8.30
Southern district	3.84	.43	2.40	3.74	6.67	8.01	4.81	-1.86	-3.20
Western district	2.14	.80	2.62	6.44	5.56	9.38	5.60	0.04	-3.78

* Limestone data from Carload Waybill Statistics, 1969, adjusted for 1970 comparable to iron ore 1969-1970 increase from Freight Commodity Statistics

** negative sign shows lower rate for secondary material

Note: Numbers in parentheses () indicate assumed number of tons of raw material per ton of steel.

Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Railroads, 1970.

Table 5-6. COMPARISON OF NATIONWIDE CLASS I RAILROAD REVENUE FOR VIRGIN AND SECONDARY STEEL RAW MATERIALS
Chemically-adjusted basis
($/ton)

Year	Virgin material						Secondary material	Differences*	
	Iron ore (1.585)	Lime-stone	Coal (.912)	Coke (.648)	Total coal basis	Total coke basis	Scrap iron & steel	Coal basis	Coke basis
1956	3.28	.55	3.15	2.31	6.98	6.14	4.03	-2.95	2.11
1957	3.47	.55	3.26	2.40	7.28	6.42	4.18	-3.10	2.24
1958	--	.55	--	--	--	--	--	--	--
1959	3.87	.55	3.17	2.69	7.59	7.11	4.42	-3.17	-2.69
1960	3.71	.55	3.10	2.64	7.36	6.90	4.06	-3.30	-2.84
1961	3.55	.55	3.21	2.70	7.31	6.80	4.19	-3.12	-2.61
1962	3.38	.55	3.02	2.64	6.95	6.57	4.08	-2.87	-2.49
1963	3.57	.55	2.93	2.80	7.05	6.92	4.12	-2.93	-2.80
1964	3.57	.55	2.85	2.87	6.97	6.99	4.15	-2.82	-2.84
1965	3.61	.55	2.85	2.93	7.01	7.09	4.20	-2.81	-2.89
1966	3.46	.55	2.75	2.83	6.76	6.84	4.20	-2.56	-2.64
1967	3.49	.55	2.75	2.97	6.79	7.01	4.33	-2.46	-2.68
1968	3.55	.55	2.75	3.08	6.85	7.18	4.31	-2.54	-2.87
1969	3.58	.55	2.85	3.43	6.98	7.56	4.37	-2.61	-3.19
1970	3.66	.55	3.13	3.58	7.34	7.79	4.83	-2.51	-2.96
1971	4.17	.55	3.40	4.19	8.12	8.91	5.48	-2.64	-3.43

*negative if lower for secondary material.

Note: numbers in parentheses ( ) indicate assumed number of tons of raw material per ton of steel.

Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Railroads, years 1956-1957, 1959-1971.

transported to the blast furnace, the virgin materials for steel cost, on a nationwide basis, $2.51 per ton more to move to the integrated mills than comparable amounts of scrap. Reviewing Table 5-6 (p.120) it appears that nationwide, on the coal basis, an approximate $2.00 to $3.00 differential in favor of scrap has existed since 1956. Thus, for unimodal railroad movement the secondary material should have an advantage over its virgin counterparts in the eyes of a cost-conscious steel executive.

Tables 5-7 (p. 122) and 5-8 (p. 123) depict the average cost of moving the steel-making raw materials by common motor carrier. The direct comparisons between iron ore and scrap for these carriers show a strong rate bias in favor of the secondary material. This is in part a consequence of the small amount of ore that moves by truck, as well as the relatively small loads on the ore trucks. Table 5-24(p. 263) shows that the ore trucks load at about 4 tons per truckload less than scrap trucks. The infrequent user transporting small volumes is not a preferential customer. Because of the small and infrequent volumes of shipments, the cost of moving a given ton of steel-making raw material by common motor carrier is thus understandably greater than the cost of moving the same amount by rail where overall usage is much greater.

Table 5-9 (p. 124) indicates that the chemically-adjusted comparison for common motor carriers is very strongly biased in favor of the secondary materials. Although the chemically-adjusted comparison omits the cost of moving the limestone because of lack of data, an addition of even the smallest amount will increase the already large bias in favor of the secondary material.

Table 5-10 (p. 125) summarizes inland water carrier shipping rates for steel-making raw materials. Tables 5-25, 5-26, 5-27, and 5-28(pgs. 264 ,266 ,267 , and 269) provide more detailed information on the rates and the routes for which they were established. The right hand column of Table 5-10 shows the direct comparisons of iron ore and scrap for the two waterway systems over which both commodities are shipped in significant quantity. These direct comparisons are based on equal mileage shipments. The numbers in parentheses indicate the mileage for the four comparable routes. It is evident that ore is moving at a cheaper average rate over comparable distances.

Table 5-7. COMPARISON OF AVERAGE MOTOR CARRIER REVENUE PER TON FOR VIRGIN AND SECONDARY STEEL RAW MATERIALS - 1969

	Average motor carrier revenues, $/net ton					
	Virgin materials				Secondary material	Difference**
Movement	Iron ore [1]	Limestone [2]	Coal [3]	Coke [4]	Scrap iron & steel [5]	Between ore and scrap [5]-[1]
Nationwide	24.96	NA	1.28	10.59	11.28	-13.68
Mid-Atlantic	16.64	NA	2.01	14.53	15.06	- 1.58
Central	20.62	NA	0.55	8.31	7.87	-12.75
Pacific	43.65	NA	12.99	17.16	11.18	-32.47

* negative sign shows lower rate for secondary material
NA= Not available

Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Motor Carriers, 1969.

Note: See Appendix E.

Table 5-8. COMPARISON OF AVERAGE MOTOR CARRIER REVENUE PER TON FOR VIRGIN AND SECONDARY STEEL RAW MATERIALS - 1970

	Average motor carrier revenues, $/net ton					
	Virgin materials				Secondary material	Difference*
Movement	Iron ore [1]	Lime-stone [2]	Coal [3]	Coke [4]	Scrap iron & steel [5]	Between ore and scrap [5]-[1]
Nationwide	21.43	NA	2.23	12.26	13.42	-8.01
Mid-Atlantic	20.91	NA	2.91	20.36	16.35	-4.56
Central	14.95	NA	1.13	8.88	10.04	-4.91
Pacific	39.54	NA	42.74	22.71	15.63	-23.91

*negative sign shows lower rate for secondary material.

Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Motor Carriers, 1970.

Table 5-9. COMPARISON OF AVERAGE MOTOR CARRIER REVENUE PER TON FOR VIRGIN AND SECONDARY STEEL RAW MATERIALS - 1970
Chemically-Adjusted Basis

Average motor carrier revenues, $/net ton of steel									
Movement	Virgin materials						Secondary material	Differences*	
	Iron ore	Lime-stone	Coal	Coke	Total coal basis	Total coke basis	Scrap iron & steel	Coal basis	Coke basis
	(1.585)	(.242)	(.912)	(.648)	[1]+[2]+[3]	[1]+[2]+[4]	(1)		
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[7]-[5]	[7]-[6]
Nationwide	33.97	NA	2.03	7.94	36.00	41.91	13.42	-22.58	-28.49
Mid-Atlantic	33.14	NA	2.65	13.19	35.79	46.33	16.65	-19.14	-29.68
Central	23.70	NA	1.03	5.75	24.73	29.45	10.04	-14.69	-19.41
Pacific	62.67	NA	38.98	14.72	101.65	77.39	15.63	-86.02	-61.76

*negative sign shows lower rate for secondary material

Note: Numbers in parentheses ( ) indicate assumed number of tons of raw material per ton of steel.

Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Motor Carriers, 1970.

Table 5-10. COMPARISON OF REPRESENTATIVE INLAND WATER CARRIER FREIGHT RATES FOR VIRGIN AND SECONDARY STEEL RAW MATERIALS - 1973
($/net ton)

	Virgin materials												Secondary material			
	Iron ore			Coal			Coke			Pig iron			Scrap iron & steel			Rate difference between ore and scrap for comparable distances*
Waterway system	Rate	Miles	Route	Rate	Miles	Route	Rate	Miles	Route	Rate	Miles	Route	Rate	Miles	Route	
Great Lakes	1.31	260	6	.75	50	14	.75	50	14	.75	50	15	3.11	260	47	1.80 (260)
	1.65	385	5										3.37	160	46	3.98 (725)
	1.96	450	9										5.25	400	48	4.74 (950)
	1.96	500	10										6.17	725	45	
	1.96	535	7										6.93	950	44	
	1.96	550	8													
	1.96	700	11													
	2.19	725	3													
	2.19	765	1													
	2.19	800	2													
	2.19	950	4													
Atlantic Waterway							4.50	650	13	2.66	105	31	1.43	60	49	
										3.05	125	30	3.68	50	50	
										3.60	215	33				
										4.16	255	32				
Mississippi	See note on Table 52.			4.25	375	20							1.47	95	41	
				6.80	1016	21							2.29	360	40	
				6.97	665	17							3.86	485	42	
				7.28	785	19							7.47	1175	43	
				7.90	1104	18										
				8.63	1115	22										
				11.17	1835	23										
Warrior	1.70	260	12	2.80	525	29				3.78	250	39	4.53	260	56	2.83 (260)
				3.46	355	28				4.61	265	37	4.77	425	55	
				4.00	500	27				4.61	425	38	4.82	435	54	
				4.70	550	25				5.52	365	35	5.91	360	53	
				5.55	810	24				7.50	425	36	7.80	685	52	
				5.90	985	26				10.43	810	34	9.41	715	51	

* negative sign shows lower rate for secondary material.

Source: Tables 5-25, 5-26, 5-27, and 5-28. See for origins and destinations of routes.

The statistical data presented up to this point demonstrate, that on a chemically-adjusted basis, secondary steel-making raw materials are moving at a lower cost to the user than their virgin substitutes. This cost differential prevails throughout the major transportation modes involved in hauling these materials. Consistently, the differential favors the use of purchased scrap iron and steel and thus electric furnaces in the investment decision, volume movements encourage shipment by rail or inland water carrier.

Paper and Paperboard Raw Materials -

The average rates for shipping paper-making raw materials by railroad are given in Tables 5-11 (p. 127) and 5-12 (p. 128). The direct variances between roundwood and wastepaper and between wood chips and wastepaper show the differences for shipping the virgin materials to non-integrated facilities. The pulp basis shows the rate differential faced by some non-integrated mills which purchase both market pulp and wastepaper.

On the basis of the two direct comparisons between virgin and secondary materials, the virgin materials are moving at a much lower average rate. In 1970, the revenue differences on a national basis favored roundwood by $6.09 per ton and wood chips by $5.43 per ton (Table 5-12). On the other hand, market pulp derived from virgin raw materials had an average revenue of $8.80 per ton higher than wastepaper. The high revenues for pulp resulted from the relatively small amount being shipped from pulping facilities to non-integrated mills. The railroad rate differential between market pulp and wastepaper definitely favored the use of secondary materials in the non-integrated mills.

Table 5-13 (p.129) shows that the proportional relationship of the revenue differences between roundwood and wastepaper, and pulp and wastepaper have been similar since 1956. This table presents a seventeen year history for paper executives who might consider these differences in their investment decisions.

Table 5-14 (p. 130) depicts the railroad loading characteristics of the paper-making materials. Wastepaper loads at about 20 tons per car less than the other three commodities. The low density of the secondary commodity is a primary causal factor in the revenue differences

Table 5-11. COMPARISON OF AVERAGE RAILROAD REVENUE PER TON FOR VIRGIN AND SECONDARY PAPERBOARD RAW MATERIALS - 1969

Movement	Average railroad revenues, $/net ton						
	Virgin materials			Secondary materials	Differences*		
	Round-wood [1]	Wood chips and residue [2]	Pulp [3]	Waste-paper [4]	Roundwood basis [4]-[1]	Wood chip basis [4]-[2]	Pulp basis [4]-[3]
Nationwide	1.87	2.49	16.38	7.40	5.53	4.91	-8.98
Eastern district	2.58	3.11	32.48	8.43	5.85	5.32	-24.05
Southern district	1.67	1.63	9.80	6.22	4.55	4.59	-3.58
Western district	2.26	3.24	15.81	7.24	4.98	4.00	-8.57

* negative sign shows lower rate for secondary material

Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Railroads, 1969.

Table 5-12.. COMPARISON OF AVERAGE RAILROAD REVENUE PER TON FOR VIRGIN AND SECONDARY PAPERBOARD RAW MATERIALS - 1970

	Average railroad revenues, $/net ton						
	Virgin materials			Secondary material	Differences*		
Movement	Round-wood [1]	Wood chips and residue [2]	Pulp [3]	Waste-paper [4]	Roundwood basis [4]-[1]	Wood chip basis [4]-[2]	Pulp basis [4]-[3]
Nationwide	1.92	2.58	16.81	8.01	6.09	5.43	-8.80
Eastern district	2.77	3.11	32.73	9.24	6.47	6.13	-23.49
Southern district	1.72	1.66	9.92	6.78	5.06	5.12	-3.14
Western district	2.28	3.44	16.50	7.67	5.39	4.23	-8.83

* negative sign shows lower rate for secondary material

Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Railroads, 1970.

Table 5-13. COMPARISON OF NATIONWIDE CLASS I RAILROAD REVENUE FOR VIRGIN AND SECONDARY PAPERBOARD RAW MATERIALS
($/ton)

Year	Virgin material		Secondary material	Differences*	
	Pulp	Roundwood	Wastepaper	Pulp basis	Roundwood basis
1956	15.22	1.95	8.33	-6.89	6.38
1957	15.91	2.05	8.83	-7.08	6.78
1958	--	--	--	--	--
1959	15.81	1.88	8.26	-7.55	6.38
1960	15.08	1.88	7.97	-7.11	6.09
1961	15.22	1.87	8.17	-7.05	6.30
1962	15.37	1.89	7.94	-7.43	6.05
1963	15.38	1.90	7.88	-7.50	5.98
1964	14.78	1.76	7.18	-7.60	5.42
1965	14.78	1.76	7.14	-7.64	5.38
1966	14.58	1.81	7.08	-7.50	5.27
1967	14.67	1.78	6.84	-7.83	5.06
1968	15.65	1.76	7.26	-8.39	5.50
1969	16.38	1.87	7.40	-8.98	5.53
1970	16.81	1.92	8.01	-8.80	6.09
1971	18.87	2.01	9.05	-9.82	7.04

* negative if lower for secondary material.

Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Railroads, years 1956-57, 1959-71.

Table 5-14. CLASS I RAILROAD REVENUE AND LOADING DATA FOR VIRGIN AND SECONDARY PAPERBOARD RAW MATERIALS - 1971

Movement	Average railroad revenue and loading statistics				
	Statistics	Virgin material			Secondary material
		Round-wood	Wood chips & residue	Pulp	Wastepaper
Nationwide	Tons/carload	59.0	56.5	57.8	35.6
	$/carload	113.0	146.0	972.0	285.0
	$/ton	1.92	2.58	16.81	8.01
Eastern District	Tons/carload	47.7	41.7	53.4	33.0
	$/carload	132.0	130.0	1748.0	305.0
	$/ton	2.77	3.11	32.73	9.24
Southern District	Tons/carload	61.2	59.3	59.9	39.1
	$/carload	105.0	98.0	594.0	265.0
	$/ton	1.72	1.66	9.92	6.78
Western District	Tons/carload	57.4	55.7	57.7	36.1
	$/carload	131.0	192.0	982.00	277.0
	$/ton	2.28	3.44	16.50	7.67

Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Railroads, 1970.

between the virgin and secondary materials. In the case of pulp, the more compact nature of this commodity has played a minor role in establishing the rates on the basis of the actual cost of moving the material.

In chemically-adjusted comparisons for rail transport, both pulp and wood chips are moving at higher rates than the equivalent amounts of wastepaper necessary to produce one ton of corrugated medium as shown in Table 5-15 (p.132). In the case of wood chips, the chemically-adjusted revenue differential is $.66, in favor of wastepaper, and the $8.00 per ton differential between pulp and wastepaper supports wastepaper over pulp. In the case of roundwood, the revenue difference favors the virgin material by $4.24 per ton. However, since most integrated mills are currently using wood chips, the latter comparison may be insignificant. Also, these comparisons are appropriate only for mills which are planning to use rail movement regardless of the raw material selected.

Table 5-16 (p.133) shows the revenue comparisons for common motor carriers. The high average revenue for roundwood moving by common motor carrier is a direct outcome of the small amount of roundwood hauled by these carriers. These small quantities do not provide sufficient leverage to cause the shippers to carry the roundwood for less than the relatively high class rates. Consequently, the high rates combined with the small truck loads encourage movement by railroads.

The movement of wood chips and residues by common motor carrier is large enough to create the leverage necessary to force the rates of all commodities, as well as wood chips, to competitive levels with railroads. Also, the advantageous loading characteristics of wood chips have led to lower motor carrier rates than for wastepaper. Pulp movement by these carriers also induces competitive rates significantly lower than wastepaper common motor carrier rates.

The loading statistics shown in Table 5-17 (p.134), specifically those for the Southern and Pacific regions, point to the compactness of residues and pulp and the "balloon nature" of roundwood and wastepaper. This low density characteristic is a definite disadvantage for the secondary material and can only be remedied with better shredding and compacting techniques.

The chemically-adjusted comparisons, shown in Table 5-18

Table 5-15. COMPARISON OF AVERAGE RAILROAD REVENUE PER TON FOR VIRGIN AND SECONDARY PAPERBOARD RAW MATERIALS - 1970
Chemically-Adjusted Basis

Movement	Average railroad revenues, $/net ton of paperboard						
	Virgin materials			Secondary material	Differences*		
	Round-wood (2.38)	Wood chips and residue (3.67)	Pulp (1)	Waste-paper (1.1)	Roundwood basis	Wood chip basis	Pulp basis
Nationwide	4.57	9.47	16.81	8.81	4.24	-0.66	-8.00
Eastern district	6.59	11.41	32.73	10.16	3.57	-1.25	-22.57
Southern district	4.09	6.09	9.92	7.46	3.37	1.37	-2.46
Western district	5.43	12.62	16.50	8.44	3.01	-4.18	-8.06

* negative sign shows lower rate for secondary material

Note: Numbers in parentheses ( ) indicate assumed number of tons of raw material per ton of liner board medium.

Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Railroads, 1970.

Table 5-16. COMPARISON OF AVERAGE MOTOR CARRIER REVENUE PER TON FOR VIRGIN AND SECONDARY PAPERBOARD RAW MATERIALS - 1970

Average motor carrier revenues, $/net ton

	Virgin materials			Secondary material	Differences*		
Movement	Round-wood [1]	Wood chips and residue [2]	Pulp [3]	Waste-paper [4]	Roundwood basis [4]-[1]	Wood chip basis [4]-[2]	Pulp basis [4]-[3]
Nationwide	24.76	2.44	5.10	9.68	-15.08	7.24	4.58
Mid-Atlantic	23.41	15.15	22.63	7.41	-16.00	-7.74	-15.22
Southern	29.00	2.72	8.59	13.43	-15.57	10.71	4.84
Pacific	12.33	2.52	2.91	8.69	-3.64	6.17	5.78

* negative sign shows lower rate for secondary material

Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Motor Carriers, 1970.

Table 5-17. CLASS I MOTOR CARRIER REVENUE AND LOADING DATA FOR VIRGIN AND SECONDARY PAPERBOARD RAW MATERIALS - 1970

Movement	Average class I motor carrier revenue and loading statistics				
	Statistics	Virgin material			Secondary material
		Round-wood	Wood chips & residue	Pulp	Wastepaper
Nationwide	Tons/truckload	15.6	22.1	20.6	13.2
	$/truckload	386.0	54.0	105.0	128.0
	$/ton	24.76	2.44	5.10	9.68
Mid-Atlantic	Tons/truckload	14.3	15.7	13.7	14.2
	$/truckload	334.0	238.0	310.0	105.0
	$/ton	23.41	15.15	22.63	7.41
Southern	Tons/truckload	16.9	22.4	16.6	16.6
	$/truckload	489.0	61.0	143.0	223.0
	$/ton	29.0	2.72	8.59	13.43
Pacific	Tons/truckload	16.9	22.5	23.2	9.96
	$/truckload	208.0	56.0	67.0	87.0
	$/ton	12.33	2.52	2.91	8.69

Source: Interstate Commerce Commission, *Freight Commodity Statistics, Class I Motor Carriers*, 1970.

(p.136) also show that wood chips and pulp are moving at lower rates than the secondary materials, while roundwood costs significantly more to transport. The relatively high rates for all types of virgin materials in the Mid-Atlantic Region are a consequence of the mills in that region using relatively little virgin raw materials. The lack of virgin raw materials traffic and the abundance of wastepaper movement in this region have resulted in the virgin materials moving at near the class rates while wastepaper rates are negotiated to much lower levels.

The API survey of actual mill receipts and wastepaper movement by railroads and private and contract motor carriers has provided some data to determine the relative rates for moving wastepaper by private and contract motor carrier. Figures 5-1, 5-2, 5-3, 5-4, 5-5, 5-6, 5-7 and 5-8 (pgs. 137,138,139,140,141,142,143 and 144) show the private and contract motor carrier rates and railroad rates for wastepaper as a function of the distance of the movement and the weight of the shipment. The data plotted as a function of distance illustrates that although the railroads generally charge less for comparable distance movements, the truckers are utilized more. Assuming the week documented by the survey is fairly representative for mill receipts, it is evident that there are many more recordings of private and contract motor carrier than rail receipts in each of the territories.

This heavy reliance on trucks reflects the mills' and wastepaper processors' perception that the combination of rates and flexibility for trucks can offer more advantageous transportation. The scatter in the data plotted as a function of weight precludes any conclusions about discounts for high weight shipments. The neutral tendency of the data might lead one to conclude that there are no rate discounts, but the scatter in the data negates such inferences.

Table 5-19 (p.145) summarizes inland water carrier rates for paper-making materials and direct differences in these rates. Tables 5-29, 5-30, and 5-31(pgs. 271,272 and 273) are more detailed exhibits of the rates and corresponding route structures. The numbers in parentheses following the rate differences indicate the mileages on similar routes. As in the case of railroads, the secondary materials generally cost more to transport by water. Depending on the distance, the cost may vary from $1.89 per ton to $4.86 per ton more to move a ton of wastepaper by barge than to move a ton of roundwood.

Table 5-18. COMPARISON OF AVERAGE MOTOR CARRIER REVENUE PER TON FOR VIRGIN AND SECONDARY PAPERBOARD RAW MATERIALS - 1970
Chemically-Adjusted Basis

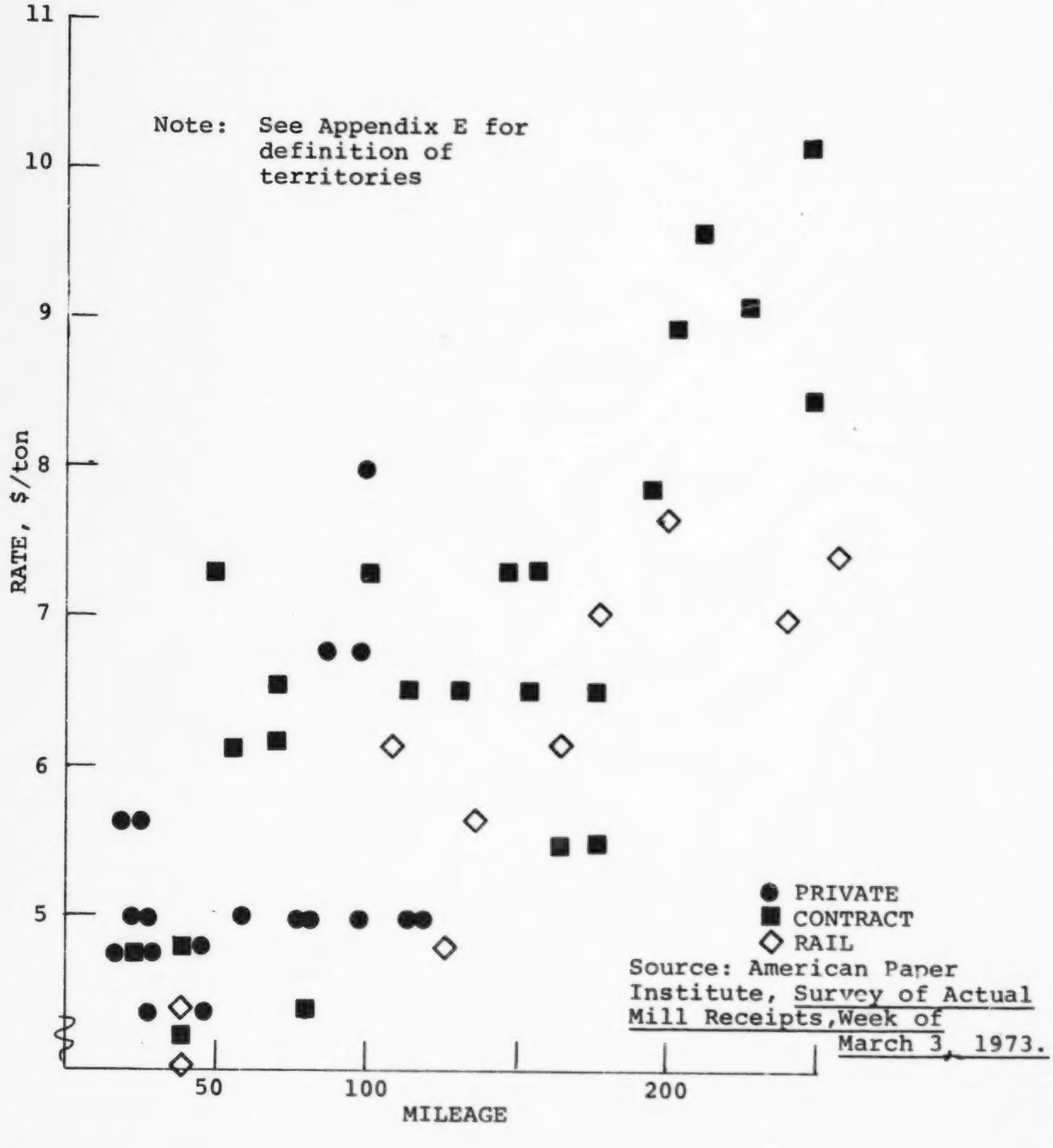
	Average motor carrier revenues, $/net ton of paperboard						
	Virgin materials			Secondary materials	Differences*		
Movement	Roundwood (2.38)	Wood chips and residue (3.67)	Pulp (1)	Wastepaper (1.1)	Roundwood basis	Wood chip basis	Pulp basis
Nationwide	58.93	8.95	5.10	10.65	-48.28	1.70	5.55
Mid-Atlantic	55.72	55.60	22.63	8.15	-47.57	-47.45	-14.48
Southern	69.02	9.98	8.59	14.77	-54.25	4.79	6.18
Pacific	29.35	9.25	2.91	9.56	-19.79	0.31	6.65

* negative sign shows lower rate for secondary material

Note: Numbers in parentheses ( ) indicate assumed number of tons of raw material per ton of liner board medium.

Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Motor Carriers, 1970.

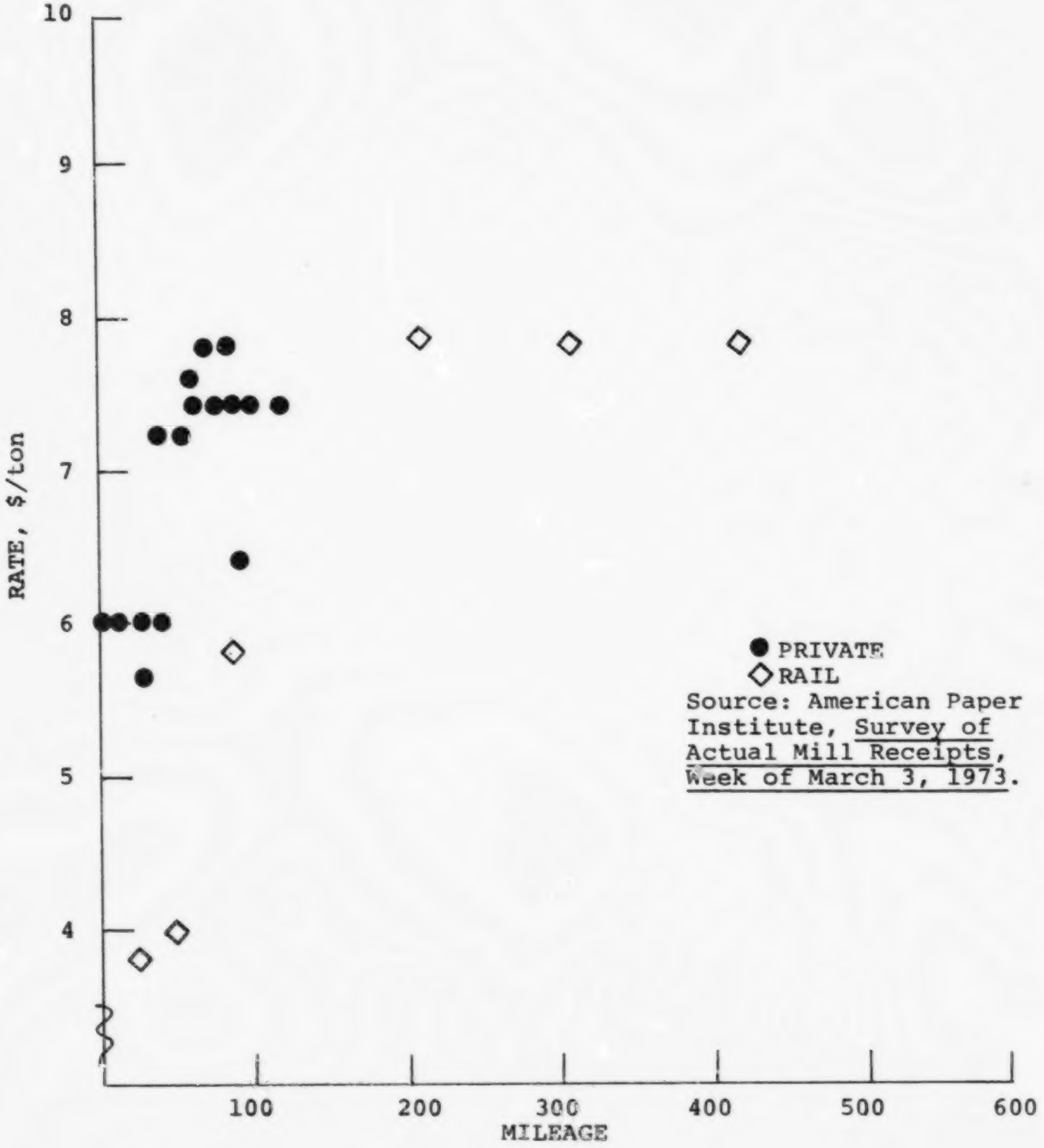
Figure 5-1. Private Carrier, Contract Carrier and Railroad Rates for Wastepaper-Western Official Territory



Note: See Appendix E for definition of territories

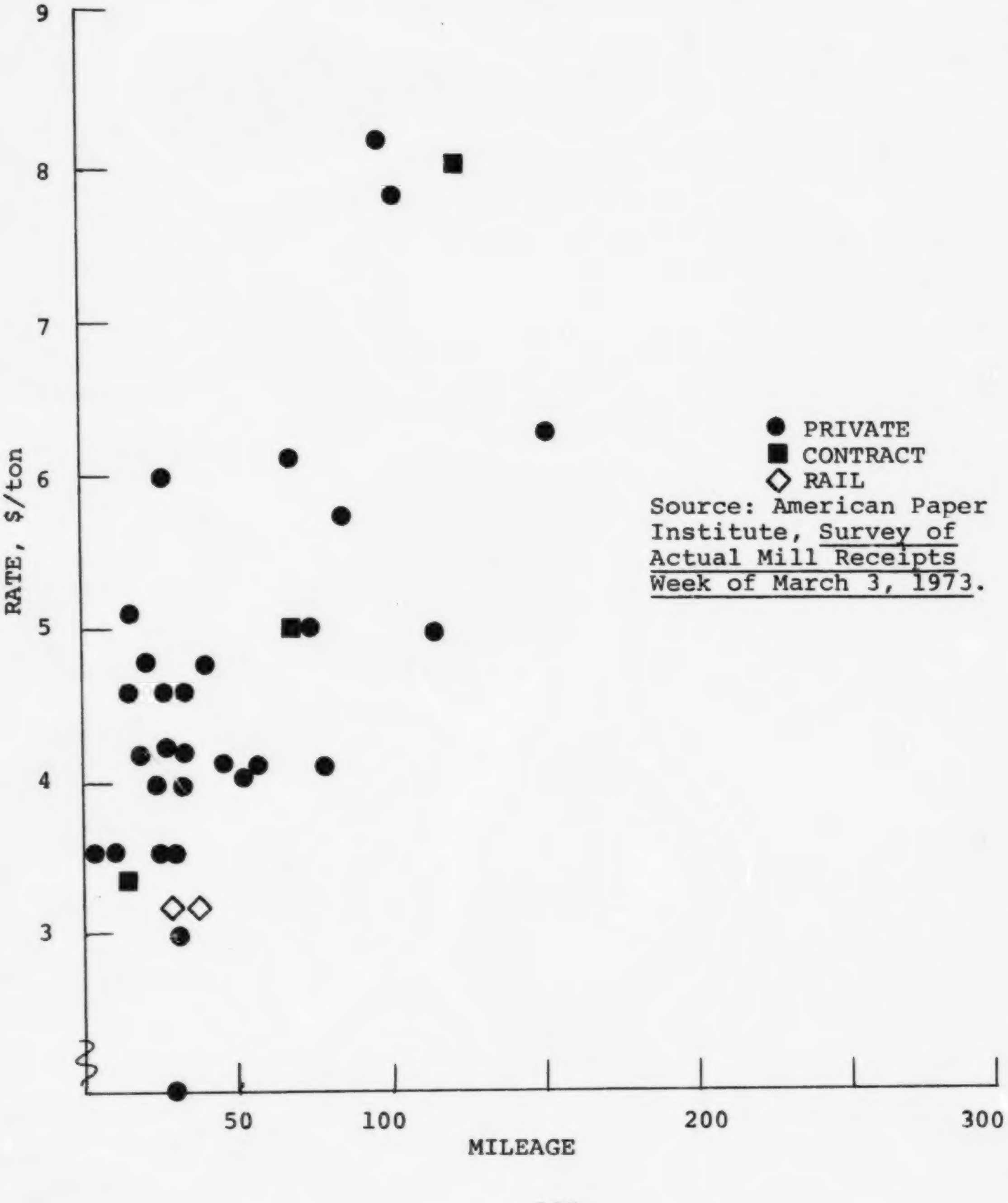
Source: American Paper Institute, Survey of Actual Mill Receipts, Week of March 3, 1973.

Figure 5-2. Private Carrier and Railroad Rates for Wastepaper-Eastern Official Territory



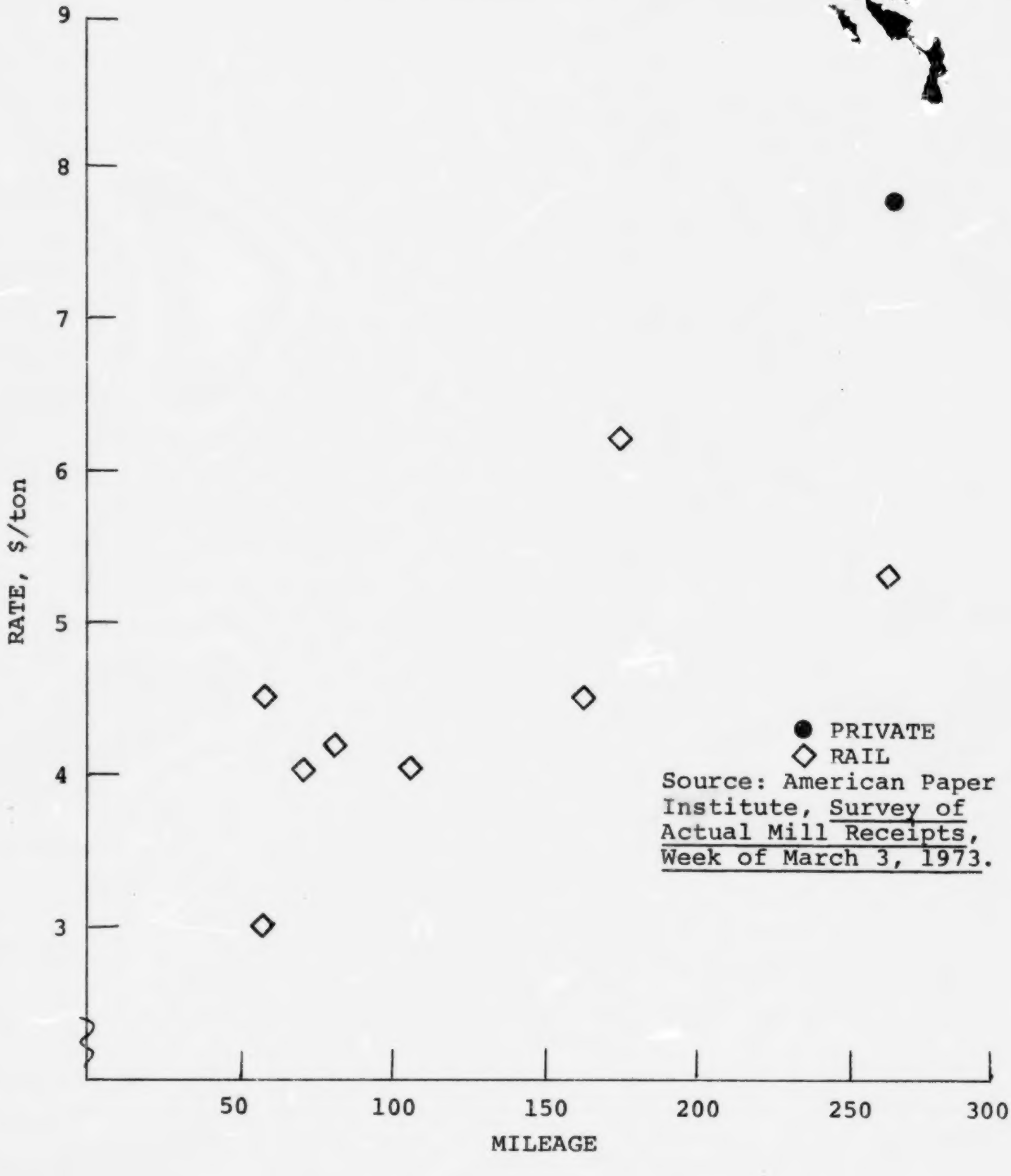
Source: American Paper Institute, Survey of Actual Mill Receipts, Week of March 3, 1973.

Figure 5-3. Private Carrier, Contract Carrier and Railroad Rates for Wastepaper - Mountain-Pacific Territory



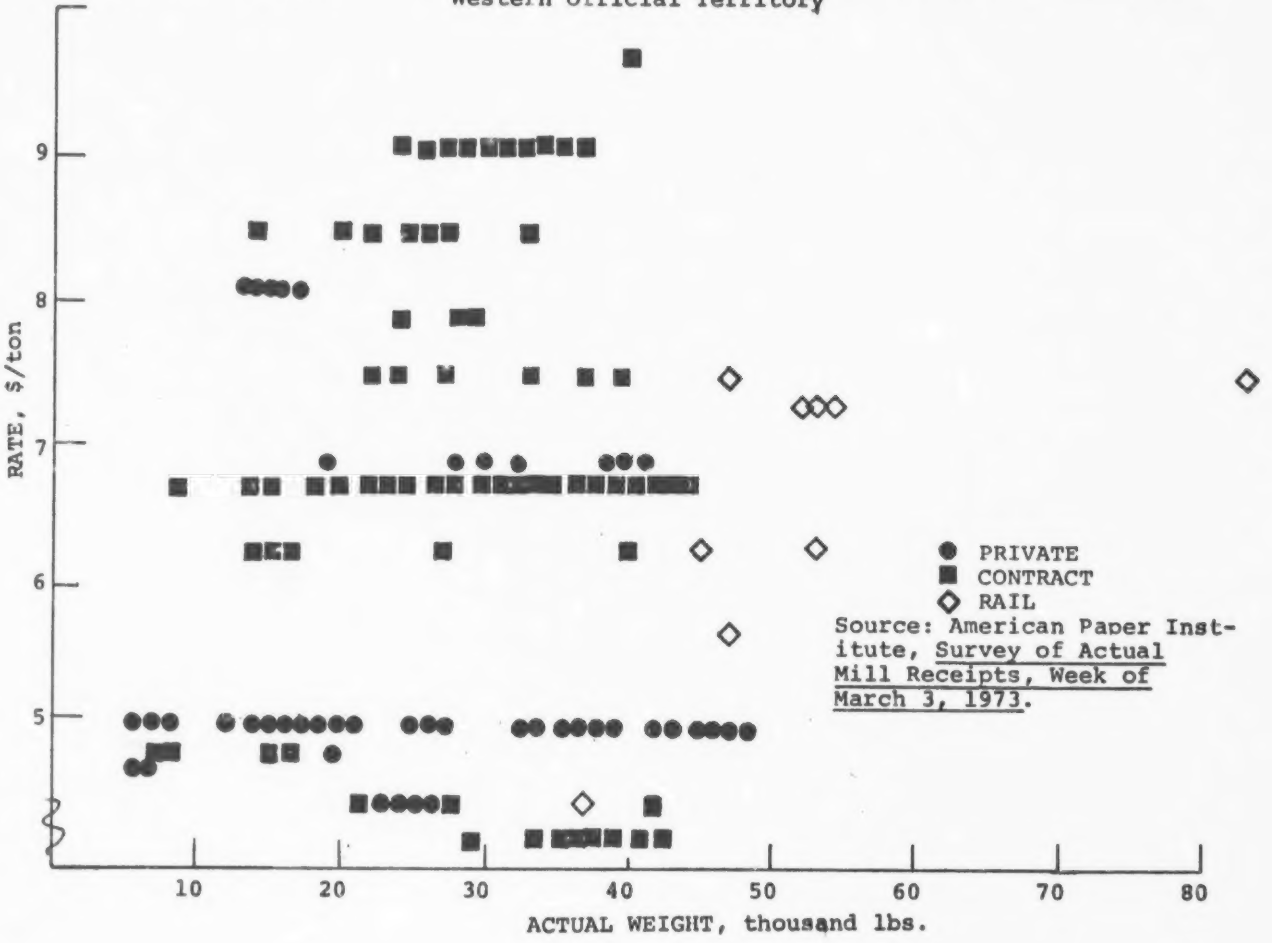
Source: American Paper Institute, Survey of Actual Mill Receipts Week of March 3, 1973.

Figure 5-4. Private Carrier and Railroad Rates for Wastepaper-Southern Territory



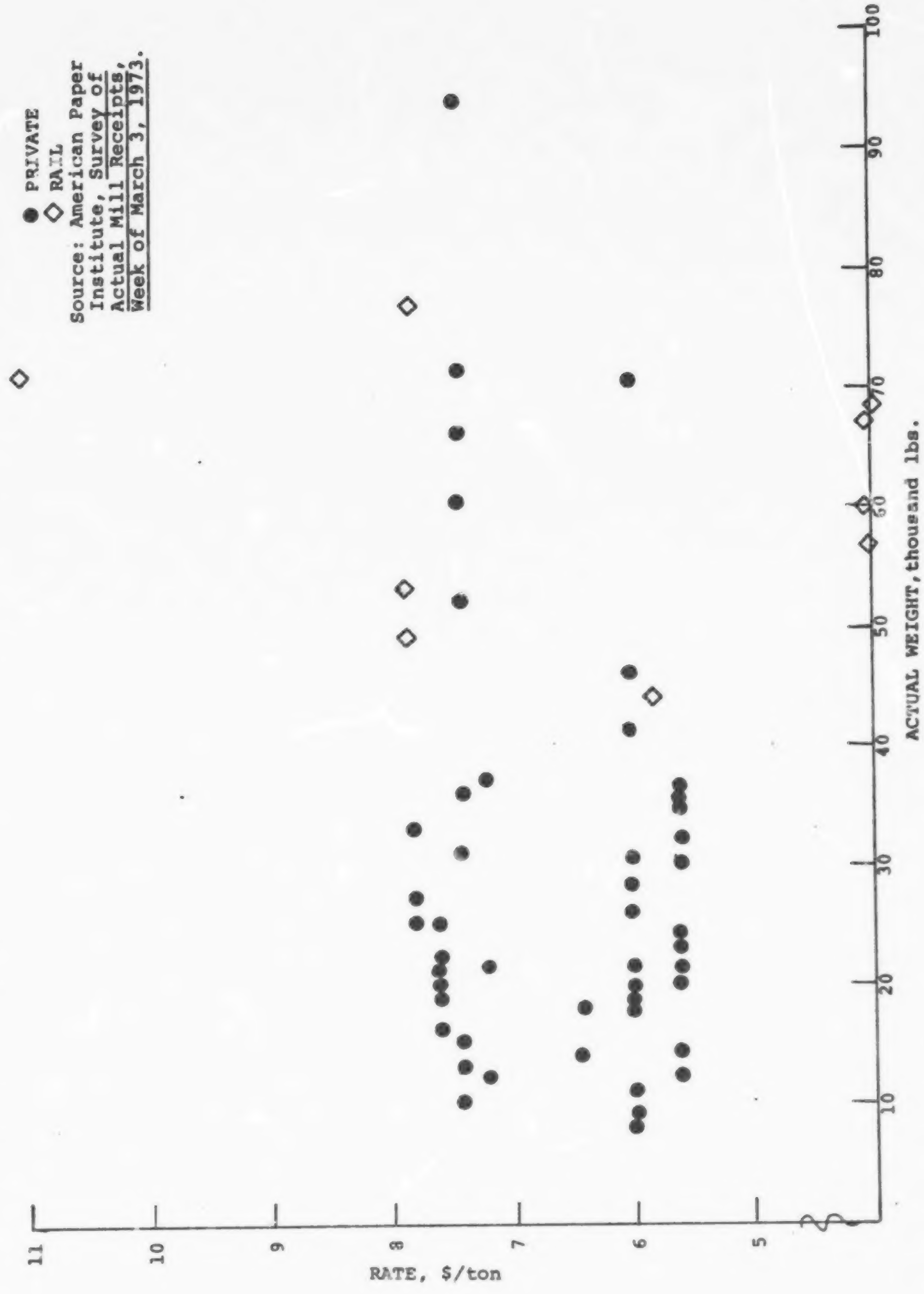
Source: American Paper Institute, Survey of Actual Mill Receipts, Week of March 3, 1973.

Figure 5-5. Private Carrier, Contract Carrier and Railroad Rates for Wastepaper-Western Official Territory



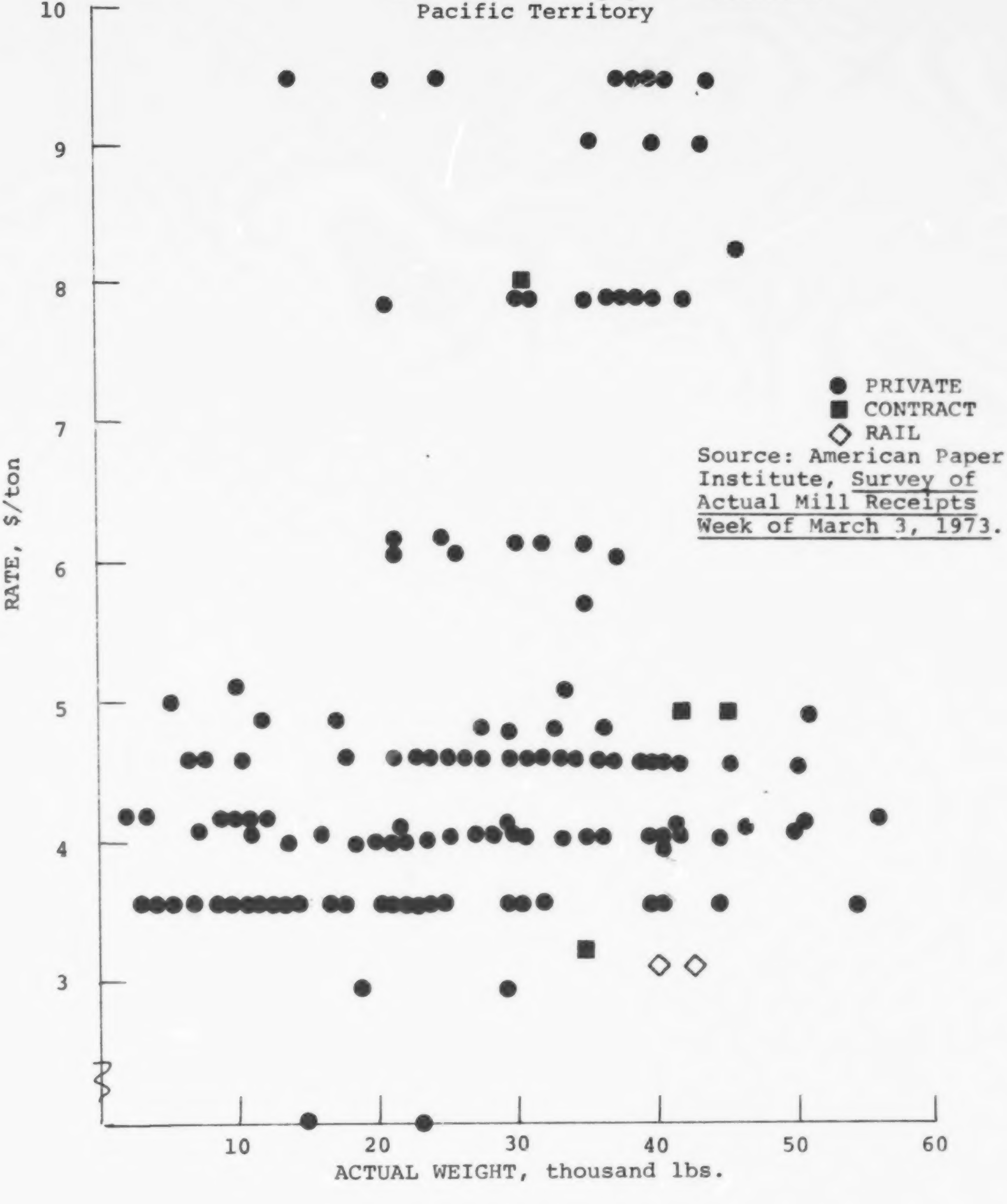
Source: American Paper Institute, Survey of Actual Mill Receipts, Week of March 3, 1973.

Figure 5-6. Private Carrier and Railroad Rates for Wastepaper - Eastern Official Territory



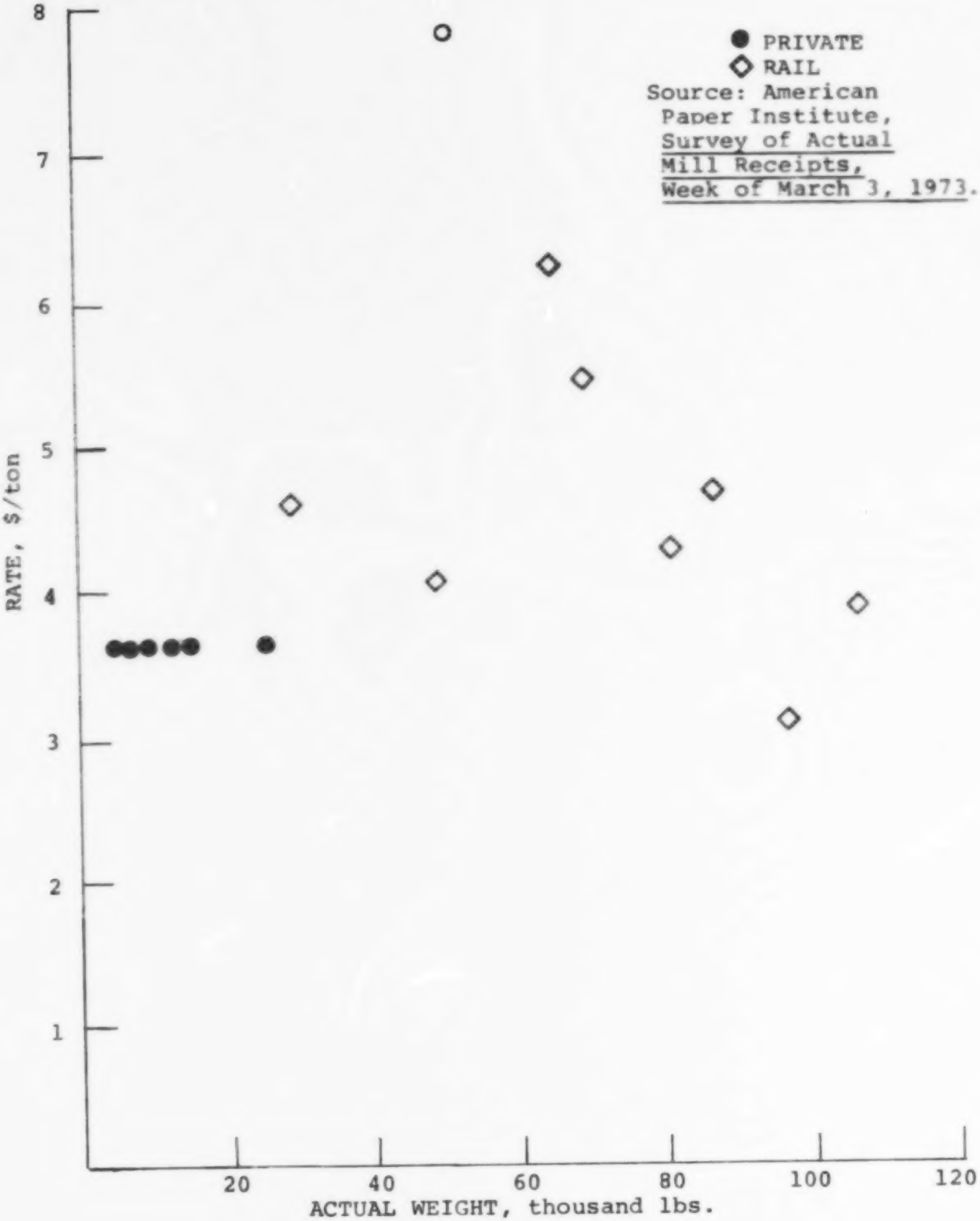
Source: American Paper Institute, Survey of Actual Mill Receipts, Week of March 3, 1973.

Figure 5-7. Private Carrier, Contract Carrier and Railroad Rates for Wastepaper - Mountain-Pacific Territory



Source: American Paper Institute, Survey of Actual Mill Receipts Week of March 3, 1973.

Figure 5-8. Private Carrier and Railroad Rates for Wastepaper - Southern Territory



Source: American Paper Institute, Survey of Actual Mill Receipts, Week of March 3, 1973.

Table 5-19. COMPARISON OF REPRESENTATIVE INLAND CARRIER FREIGHT RATES FOR VIRGIN AND SECONDARY PAPERBOARD RAW MATERIALS
1973

Direct Basis

	Virgin materials*						Secondary material			Rate difference between virgin & secondary material for comparable distances	
	Roundwood			Pulp			Waste paper				
Waterway system	Rate	Miles	Route	Rate	Miles	Route	Rate	Miles	Route	Roundwood basis	Pulp basis
Great Lakes											
Mississippi	3.75	500	1	3.00	400	6	2.17	685	15	1.89 (550 & 600)	
	4.00	806	2	3.80	340	8	4.76	660	11		
	7.71	928	4	3.94	804	7	5.64	600	12	3.82 (928 & 985)	
	7.04	1029	3	4.96	944	10	11.53	985	13		6.57 (944 & 985)
				5.31	860	9	11.90	1085	14	4.86 (1029 & 1085	
Atlantic				6.75	775	5					

Chemically-Adjusted Basis

	Virgin materials*						Secondary material			Rate difference between virgin & secondary material for comparable distances	
	(2.38) Roundwood			(1) Pulp			(1.1) Waste paper				
Waterway system	Rate	Miles	Route	Rate	Miles	Route	Rate	Miles	Route	Roundwood basis	Pulp basis
Great Lakes											
Mississippi	8.93	550	1	3.00	400	6	2.39	685	15	2.72 (550 & 600)	
	9.52	806	2	3.80	340	8	5.24	660	11		
	18.35	928	4	3.94	804	7	6.20	600	12	5.67 (928 & 985)	
	16.76	1029	3	4.96	944	10	12.60	985	13		7.72 (944 & 985)
				5.31	860	9	13.09	1085	14	3.67 (1029 & 1085)	
Atlantic				6.75	775	5					

* information on wood chip rates was unavailable.

Source: Tables 5-29, 5-30 and 5-31.

However, on a chemically-adjusted basis, the secondary material in Table 5-19 (p.145) is less expensive to move by $2.72 per ton (550 and 600 mile comparison), by $5.67 per ton (928 and 985 mile comparison) and by $3.67 per ton (1029 and 1085 mile comparison). Thus, inland water carrier movement strongly supports wastepaper over roundwood for equal distance movements on a chemically-adjusted basis.

These revenue and rate data for paper-making raw materials have indicated that on a chemically-adjusted comparison the secondary materials move by railroad at cheaper average rates. This appears to be a consistent pattern in all modes as common motor carriers and inland water carriers generally move wastepaper at a lower rate than some of the competing virgin materials. The one week API survey indicates that while private and contract motor carriers charge more to move wastepaper than railroads, the cost is outweighed by the flexibility of this transportation mode; consequently, the movement by this mode is quite popular.

Service Cost Differentials

The rate data previously discussed represent the quantifiable aspects of transportation costs. The factors listed in Tables 5-20 (p. 147) and 5-21 (p. 148) are the primary non-quantifiable or service costs which apply with differing degrees of severity to all transportation modes. The spatial characteristics show local or regional factors which may influence costs; e.g., the high costs of maintaining inventories in urban areas or the high cost of stop-and-go driving in these areas. Shipment size, the variability of shipments, and delay times are indicators of inventory requirements and economies of scale. Expenses such as special or auxiliary services are in addition to normal rate charges.

Assessing the cost differentials for the service characteristics listed in the two tables for virgin and secondary materials is a formidable task. Part of the difficulty is the fixed investment in virgin transportation equipment made by transportation and production companies over the past years. This specially designed equipment currently being financed and the established fixed facilities cause most of the differences in transportation service characteristics.

Table 5-20. SERVICE COST FACTORS FOR VIRGIN AND SECONDARY STEEL-MAKING RAW MATERIALS

Cost factor	Virgin raw materials			Scrap iron and steel
	Iron ore	Coal	Limestone	
Spatial characteristics	Sources: Northern Great Lakes & Import Ports Markets; Lower Great Lakes and Alabama	Generally near mill	Generally near mill	Sources: Diversified throughout population centers Markets: Electric furnace mills usually near population centers
Shipment size	Large volumes, unit trains, or large barge	Large Volumes, unit trains, or large barge	Large volumes	Single carloads and truckloads
Equipment requirements	Special ore cars dedicated to service	Special hopper cars dedicated to service	Hopper cars	Old gondolas, generally have inadequate capacity
Delay times	Fast delivery by unit trains	Fast delivery by unit trains	Prompt delivery	Slow and intermittent delivery with delays up to 10 days beyond reasonable times
Auxiliary services	Special loading and unloading facilities at ore docks	Special coal handling facilities	None	None
Variability of shipments	No winter shipments on Great Lakes	None	None	Delayed function of steel mill demand which is cyclic

Table 5-21. SERVICE COST FACTORS FOR VIRGIN AND SECONDARY PAPER- AND PAPERBOARD-MAKING RAW MATERIALS

Cost factor	Virgin raw materials		Wastepaper
	Roundwood	Wood chips and residues	
Spatial characteristics	Source: Softwood and hardwood forests of the South and Pacific Northwest Market: Mills located in the forests	Source: Softwood and hardwood forests of the South and Pacific Northwest Market: Lumber mills located in the forests	Source: Major population centers Markets: Mills located near major population centers
Shipment size	Large volumes, multiple car shipments	Large volumes, multiple car shipments	Single car or truck shipments
Equipment requirements	Special log cars dedicated to service	Special hopper cars and trailers dedicated to service	Available boxcars and covered truck trailers (except California)
Delay times	Prompt delivery by large trains	Prompt delivery by trains and trucks	Intermittent delivery by rail. Truck delivery usually prompt
Auxiliary services	Special loading and unloading facilities	Special unloading facilities	Insurance requirements on flammable inventories
Variability of shipments	Winter down time during snow and summer down time during fire damages	Winter down time during snow and summer down time during fire damages	Delayed function of paper and board mill demand

For instance, the long-term movement of iron ore created the incentive to build special ore loading facilities at lake ports and the railroads purchased special cars and dedicated them to ore carriage. These investments ensure that the virgin materials will receive much faster, more reliable and more flexible movement, i.e., better service and lower costs. Unless similar types of investments are made for secondary materials, their movement is likely to incur poorer and more costly service.

The differences described in the two tables indicate that secondary materials in both the paper and steel industries have higher service costs than comparable virgin materials. In the case of steel where the movements are generally confined to rail, the higher service cost would somewhat reduce the chemically-adjusted cost advantage in Table 5-5 (p.119). The exact amount of the reduction cannot be determined from available data.

In the paper industry, the desirability of moving wastepaper on private motor carriers complicates the determination of the influence of service costs. If a new mill were being designed completely around rail transportation, the service cost differentials favoring the virgin materials would probably add to the rate differences shown in Table 5-15 (p.132) to indicate that roundwood and wood chips move at lower costs than comparable amounts of wastepaper; pulp would still cost more to transport than wastepaper. If the wastepaper were going to be moved by private or contract truck, then the $8.81 shown in Table 5-15 would increase to about $9.20 based on our estimates of the differential between private and contract carriage costs and rail costs.

Summary of Rate Differentials

Thus, upon consideration of all factors, such as mode of transport, service cost, and the chemical-adjustment variable, it is possible to make cost generalizations regarding movement of virgin and secondary raw materials in the steel and paper industries. Data documenting revenues for steel-making raw materials moved by railroad, the mode by which the majority of these materials are transported, reveals that in a direct comparison, on a nationwide basis, iron ore has been less expensive to move than scrap iron and steel.

However, when other elements in addition to iron ore are considered as input and are chemically-adjusted, the secondary material does appear to move on the average for less than virgin.

A direct comparison of motor carrier revenues reveals that scrap iron and steel move for a considerable amount less than iron ore. A chemical-adjustment and a consideration of a combination of virgin materials only increases the noticeable differential in favor of the secondary material in those revenues recorded for steelmaking materials.

A direct comparison of rate data compiled for inland water carriers shows that ore moves at a less expensive average rate than scrap; however, sufficient information is not available to determine whether adjustment on a chemical basis would reverse the rate differential or continue the current preference.

Examination of transportation of raw materials for the paper-making industry illustrates that in a direct and chemically-adjusted comparison of revenues for railroads, wastepaper is consistently less costly to move than pulp and consistently more costly to move than roundwood. Variation occurs in the wastepaper and wood chip differential; wood chips being cheaper in a direct comparison, and, on the average, more expensive on a chemically-adjusted basis.

Although minimal movement of some paper-making materials is made by common motor carrier, study of those revenues available leads to the conclusion that on a direct comparison basis, secondary material is a good deal less expensive to transport than roundwood and more expensive on the average than wood chips or pulp. Compared after chemical adjustment, the revenue differential between wastepaper and roundwood favors wastepaper to an even greater extent and remains generally more expensive than wood chips or pulp.

Inland water carrier rates are higher for wastepaper than for roundwood or pulp. The differential is reversed, however, to favor wastepaper shipment on a chemical-adjustment basis.

RAW MATERIALS TRANSPORTATION COSTS COMPARED TO PRODUCTION COSTS

The Steel Industry

Interviews with steel industry experts and steel companies have indicated that in 1970 steel was being produced for about $75 per ton in typical BOF and electric furnaces.[4] This figure included the cost of raw materials, transportation of raw materials, energy inputs, labor and overhead allowances. It is used as representative of the steel industry in order to calculate the ratio of transportation costs to production costs.

The transportation costs used in calculating the ratio were the chemically-adjusted costs per ton of steel shown in Table 5-5 (p.119). The use of these costs reflects the need to move steel-making raw materials by rail.

	Transportation cost ($/ton)	Ratio of transportation cost to production cost (%)
Virgin material	7.34	9.85 (coal) 10.45 (coke)
Secondary material	4.83	5.84 (coal)

Using the coal basis it would cost $7.34 per ton of steel to move the virgin materials into the integrated facility and $4.83 per ton of steel to transport the scrap to an electric furnace. These transportation costs are 9.85 percent and 5.84 percent of the average cost of producing a ton of steel. If the coke basis is used for these calculations the transportation costs for virgin materials are 10.45 percent of production costs.

The transportation costs generally constitute less than 10 percent of the production cost. Therefore, even a seemingly large 10 percent change in transportation costs will only affect production costs by 1 percent. This indicates that the importance of transportation costs in the investment decision is probably at best a second order consideration compared to more primary considerations of current technology used, available capacity in plant and equipment, available skill and labor pools, ownership of natural resources, ownership of shipping vehicles and many others.

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[4] Edwin F. Brush III, Ph.D., Metallurgical Consultant, and Merton Fleming, Ph.D., Professor of Metallurgy, MIT.

This second order level of transportation costs is reflected in how steel industry investment decisions are made. Generally, the selection of a particular type of raw material is made prior to considering transportation costs since the costs are manageable and can be optimized pursuant to the materials decision. By locating the mill properly and managing the transportation network, the steel company is able to reduce the cost to the relatively low level indicated previously.

The Paper and Paperboard Industry

Table 5-22 (p. 153) shows the results of a 1967 survey conducted by the API to determine the relative proportion of transportation costs in the paper industry. Discussions with paper industry personnel indicate that the results of the survey are probably still valid. As can be seen, the inbound freight costs (primarily raw materials costs) are 4.22 percent of sales for integrated companies and only 1.74 percent of sales for non-integrated mills. Again, the inference must be made that the raw materials transportation costs are not significant factors in the investment decision.

The Significance of Transportation Costs

The cost of moving the raw materials to the production facility does, however, comprise a significant percentage of the price of the raw material. Tables 5-32, 5-33, 5-34, 5-35, 5-36, 5-37, 5-38, and 5-39 are some representative prices for steel and paper raw material commodities during recent time periods and at different geographic locations. Comparing these prices and the average rail rates given in the previous section, transportation costs appear to be about 21 percent (2.31/11.00) of iron ore prices and about 18 percent (4.83/27.00) of no. 2 scrap bundles. Similarly, transportation costs are about 11 percent (1.92/17.00) of roundwood prices in the South, 16 percent (2.58/16.40) of southern wood chip prices and 50 percent (8/16) of old corrugated container prices. These com-

Table 5-22. TRANSPORTATION COSTS FOR PAPER AND PAPERBOARD PRODUCERS

Size, $000	Net sales	Freight costs,%		
		In	Out	Total
Integrated companies				
Sales under $25,000	100.0	3.02	5.67	8.68
$25,000-$50,000	100.0	6.52	5.17	11.99
$50,000-$100,000	100.0	5.02	6.67	11.70
$100,000 and over	100.0	4.12	5.97	10.09
Total	100.0	4.22	5.99	10.21
Non-integrated companies				
Sales under $5,000	100.0	0.72E	3.43	4.15
$5,000-$10,000	100.0	0.76E	3.63	4.39
$10,000 and over	100.0	2.07	3.23	5.30
Total	100.0	1.74	3.32	5.05
Grand total	100.0	4.16	5.93	10.09

E - Estimated

Source: American Paper Institute Survey, 1967.

paratively high percentages indicate that the transportation costs are significant to the scrap industries. Transportation is a major factor in their profit margins and will play an important role in their business projections and expansion.

THE CARRIERS' COSTS

The carriers' costs have received slight attention in this study. These costs are not directly relevant to the investment decision, nor is there a great deal of available data or reliable techniques for their calculation. The costs presented in this study were developed primarily for use in establishing any future strategies to alter secondary materials transportation costs.

Steel Industry Railroad Costs

Using procedures from Statement No. ICI-69, Rail Carload Cost Scales by Territories for the Year 1969, the ICC lists the railroad carriers' variable costs as $1.70 per ton of iron ore shipped and $2.28 per ton of scrap iron and steel in the Official Territory for 1969. From Table 3-1 (p.25) it is evident that the average revenue generated from one ton of iron ore was $5.66 and $4.12 per ton for scrap iron and steel in this territory during 1969. Although the $5.66 and $4.12 figures are comparatively high in relation to the dollar per ton figures for Nationwide, Southern and Western, they are the most representative revenues as the majority of iron ore and scrap material is transported by railroad within the Official Territory. After subtracting the variable costs from the revenue, iron ore contributes $3.96 per ton to fixed costs while scrap contributes $1.84 per ton.

Paper Industry Railroad Costs

Table 5-23 (p.157), also taken from ICC calculations, conveys the difference between variable costs for wastepaper and the revenue generated by this commodity on railroads. These costs were derived on a carload rather than a weight basis; nevertheless, they do illustrate that in percentage terms wastepaper is making a significantly lower contribution to fixed costs than scrap iron and steel.

Motor Carrier Costs for Wastepaper

Since a majority of wastepaper moves by truck, an attempt was made to estimate the out-of-pocket costs of the truckers. The individual companies were unwilling to divulge cost data; therefore, the ICC Highway Form B was used to determine common carrier costs. Assuming that there are only small economies of scale and that the private and contract carriers operate efficiently, these costs should be representative of the private and contract truckers who haul the majority of wastepaper. Figures 5-9, 5-10 and 5-11 (pgs.158,159 , and 160) show the calculated costs for three regions of the country where, as data in Chapter IV indicates, there is significant amount of wastepaper movement. The data points on the plots are common motor carrier class rates between the indicated cities as origin and destination points. The costs are shown by the lines as a function of distance between the cities. These are fully allocated costs including a factor for fixed costs.

The difference between city class rate points and cost lines is the shippers' margin. The three cost lines represent the cost variability due to density variations of wastepaper. Tight baling pushes the cost near the lower line, while loose baling and no shredding force it near the upper boundary.

The class rates appear to allow for 40 to 50 percent margins for all territories. Actually very little wastepaper moves at these rates and those common carriers which do charge class rates discourage the movement of this undesirable commodity.

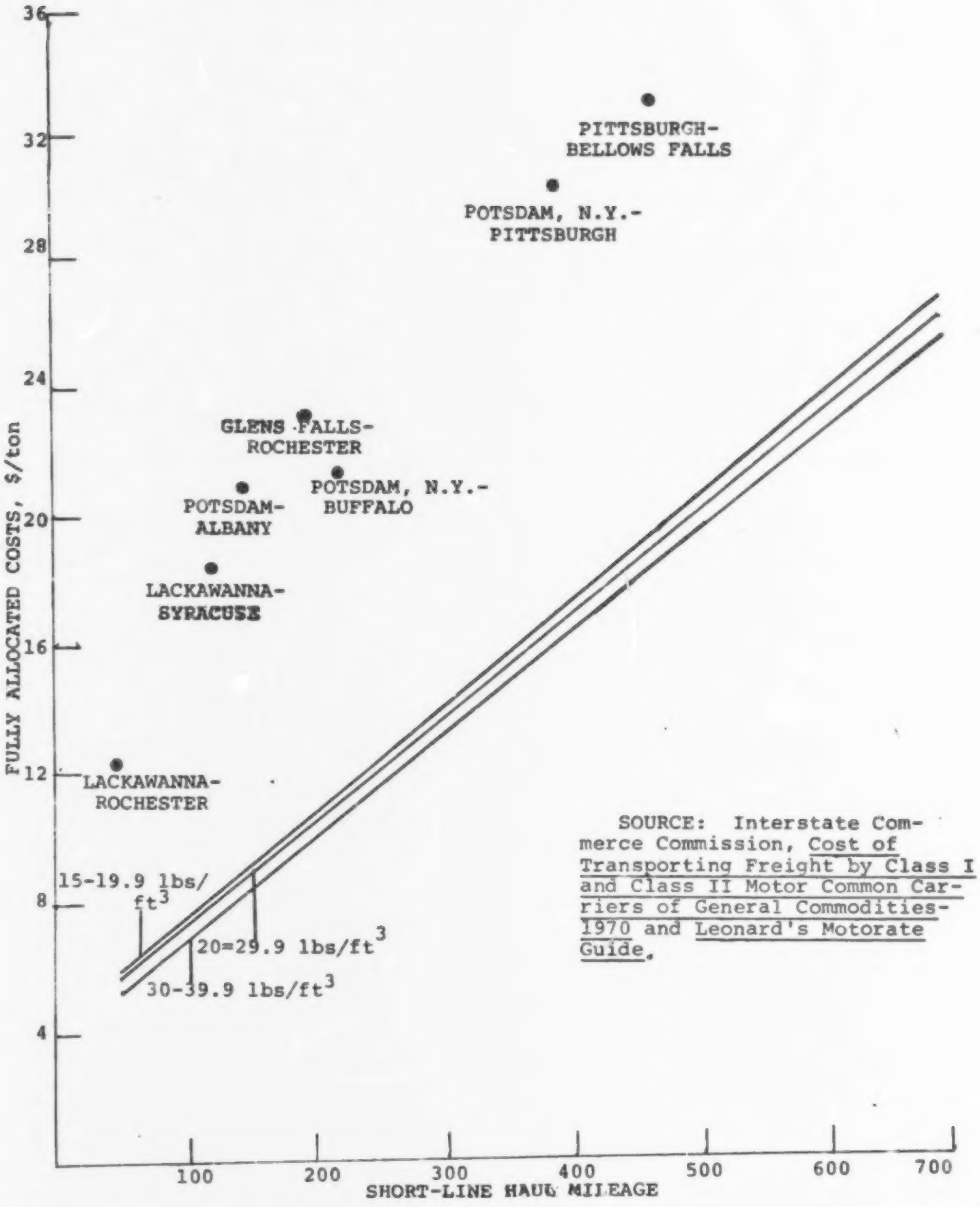
The API survey of private and contract carriers indicated an average transport cost of $8 per ton. Assuming that the operating costs in Figures 5-9, 5-10 and 5-11 (pgs. 158,159 and160) are representative for private and contract carriers and that the transportation costs are $8 per ton, then wastepaper movement by this mode would have had to move somewhat less than 160 miles (intersection of the line shown perpendicular to the $8 per ton cost and the least cost line on Figure 5-10). Conversations with paperstock dealers substantiated that 160 to 180 miles was usually the maximum distance between processing facilities and the consuming mills. Thus, the costs shown in Figures 5-9, 5-10 and 5-11 are probably good approximations of the private and contract carriers' operating costs.

Table 5-23. RAILROADS' AVERAGE COST AND PROFIT PER CAR OF WASTEPAPER
(rate - ¢/100 lbs.)

Territory	Miles	Rate - maximum weight-80,000 lbs.	Revenue per car	Average cost per car	% Profit per car
Eastern	96	28	$224.00	$179.20	25
	225	40	320.00	236.00	35
	298	43	344.00	280.00	23
		80,000 lbs.			
Southern	100	18	144.00	114.40	20
	168	22	176.00	143.20	23
	205	27	216.00	164.80	31
		50,000 lbs.			
Western	150	37	185.00	158.50	14
	300	50	250.00	214.50	14
	500	63	315.00	289.00	8

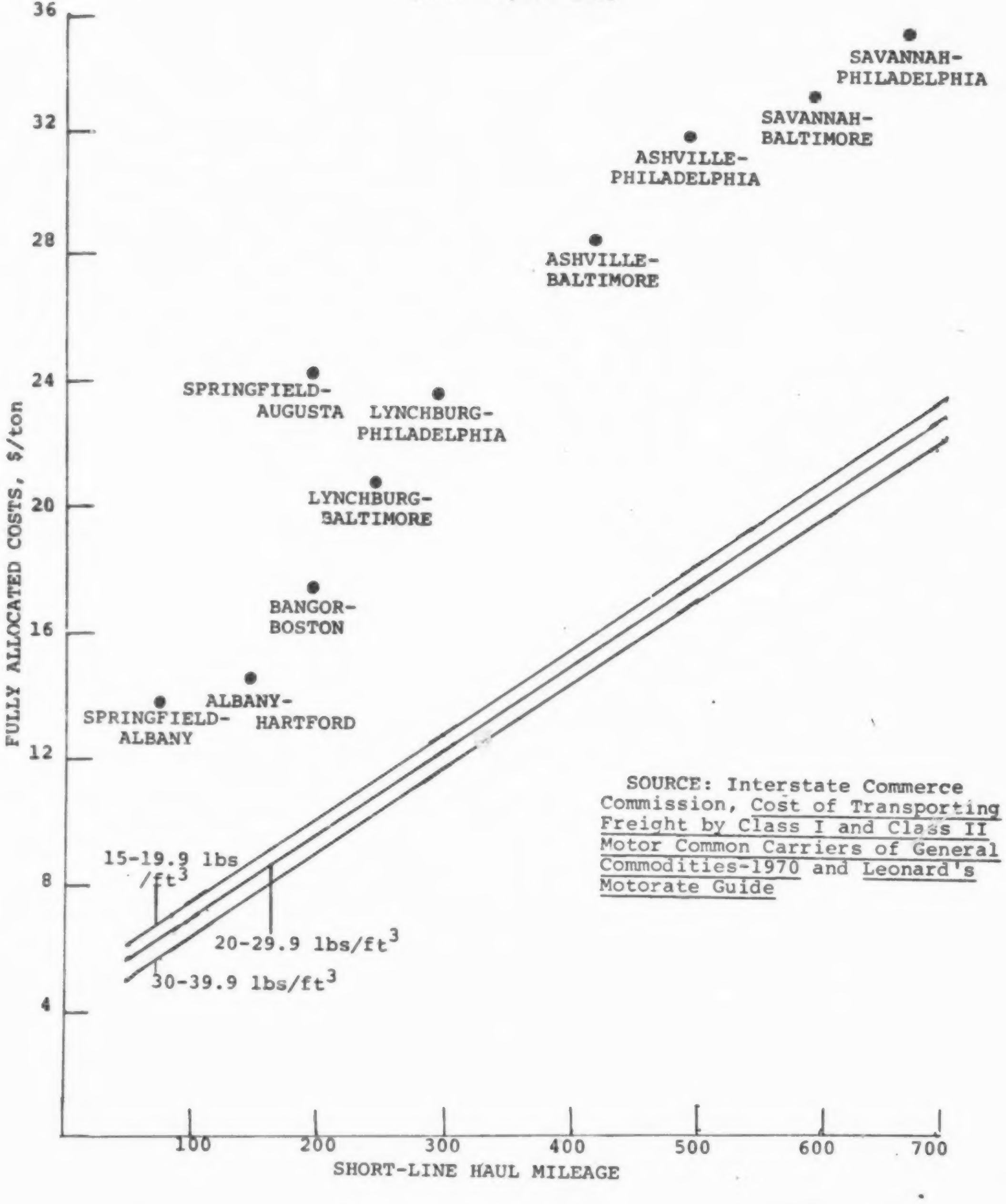
Source: Cost Per Car -- Rail Cost Scales by Territories ICI-68, updated 10 percent.

Figure 5-9. Motor Common Carrier Out-of-Pocket Costs -
Middle Atlantic Territory
(over 40,000 lbs.)



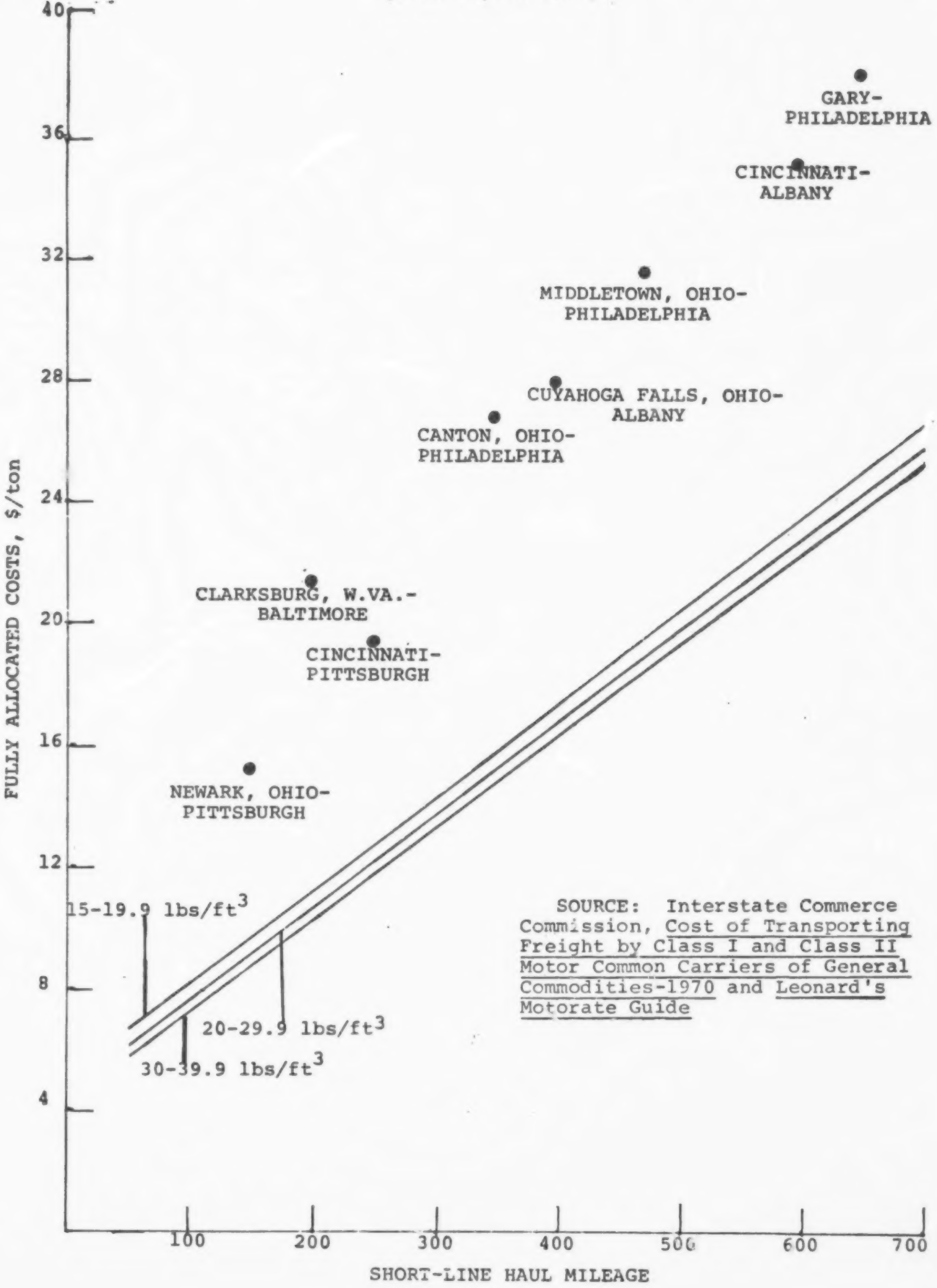
SOURCE: Interstate Commerce Commission, Cost of Transporting Freight by Class I and Class II Motor Common Carriers of General Commodities-1970 and Leonard's Motorate Guide.

Figure 5-10. Motor Common Carrier Out-of-Pocket Costs - East South Territory
(over 40,000 lbs)



SOURCE: Interstate Commerce Commission, _Cost of Transporting Freight by Class I and Class II Motor Common Carriers of General Commodities-1970_ and _Leonard's Motorate Guide_

Figure 5-11. Motor Common Carrier Out-of-Pocket Costs - Eastern Central Territory (over 40,000 lbs.)



SOURCE: Interstate Commerce Commission, Cost of Transporting Freight by Class I and Class II Motor Common Carriers of General Commodities-1970 and Leonard's Motorate Guide

REGRESSION ANALYSIS

The chemically-adjusted comparisons for transportation costs of virgin and secondary raw materials in the steel and paper industries have verified that on the average scrap iron and steel move at less cost than equivalent amounts of virgin raw materials; wood chips and wastepaper seem to cost about the same to transport, although transportation rates favor the movement of roundwood over the secondary material. The subsequent comparison of transportation costs and production costs indicated that the relative size of the transportation costs generally minimized their importance as primary elements in the investment decision. Thus, it can be concluded that the existing transportation cost differentials do not greatly influence those investment decisions pertaining to the use of secondary materials.

In order to provide some empirical support to this conclusion, a regression analysis has been conducted. The analysis has been limited to the steel industry because of the unimodal nature of the movement of virgin and secondary materials in this industry and because of the availability of data for the steel-making raw materials. The possibility of switching modes for wastepaper movement and the lack of adequate cost data on private and contract carriers for relatively long time periods made a similar analysis for the paper industry more difficult under the constraints of this study.

The analysis was a two variable linear correlation using a least squares fit to the data. The dependent variable was the ratio of purchased scrap to the sum of all scrap and iron ore consumption. The ratio is indicative of the relative use of purchased scrap as compared to total raw materials. The independent variable was the difference in average railroad rates for scrap iron and steel and virgin raw materials. Three rate differences were used in the regressions.

(1) The first independent variable used was the average rate difference between scrap and iron ore--the direct comparison mentioned earlier and recorded in Table 5-3 (p.117).

(2) The second independent variable was the chemically-adjusted average rate difference between scrap and the equivalent virgin raw

materials assuming that coal was moved to the integrated facility.

(3) The third independent variable was also a chemically-adjusted difference but on the coke basis.

Each rate difference was calculated on the basis of nationwide average rates. Table 5-6 (p.120) shows the rate difference data used for the latter two rate differences. These data and the data on the purchased scrap ratio were collected back to 1956 and the regressions which were made showed the correlation between the variables for the fifteen year period to 1971.

The statistical significance of the regressions is very low. This low statistical significance means that the data is very scattered and that the regression line which shows the correlation between the two variables has been drawn on the basis of only the slightest indication of any correlation between the two variables (i.e. low R^2). Two of the regressions do indicate a negative relationship between the rate differences and the ratio of purchased scrap. Using the rate differences between scrap and ore as the independent variable, Figure 5-12 (p. 128) shows that an increase, in favor of the virgin material, of $1 per ton in the rate difference could result in a 1.9 percent decrease in the relative amount of scrap being recycled. If the chemically-adjusted rate difference with the coal basis is used, then, as shown in Figure 5-13 (p. 164), a $1 per ton rate increase can result in a decrease of 2.5 percent scrap usage. However, using the chemically-adjusted coke basis, shown in Figure 5-14, a $1 per ton increase in the rate difference would indicate a corresponding increase in the scrap ratio. This latter result is contrary to normal expectation and is suspect because of the small number of integrated mills shipping coke significant distances. But it does point up the difficulty of establishing a good basis for rate comparisons.

The trend lines which have resulted from the two variable linear regression analyses do not provide the empirical evidence necessary to support the conclusion drawn at the beginning of this subsection. The negative slope of the regression line shows that the relative amount of scrap being used by the steel industry is correlated to transportation rate differences. But the low correlation coefficients shown on the plots make the

Figure 5-12. Proportion of Secondary Materials Consumed as a Function of Railroad Rate Differential - Differential Between Ore and Scrap

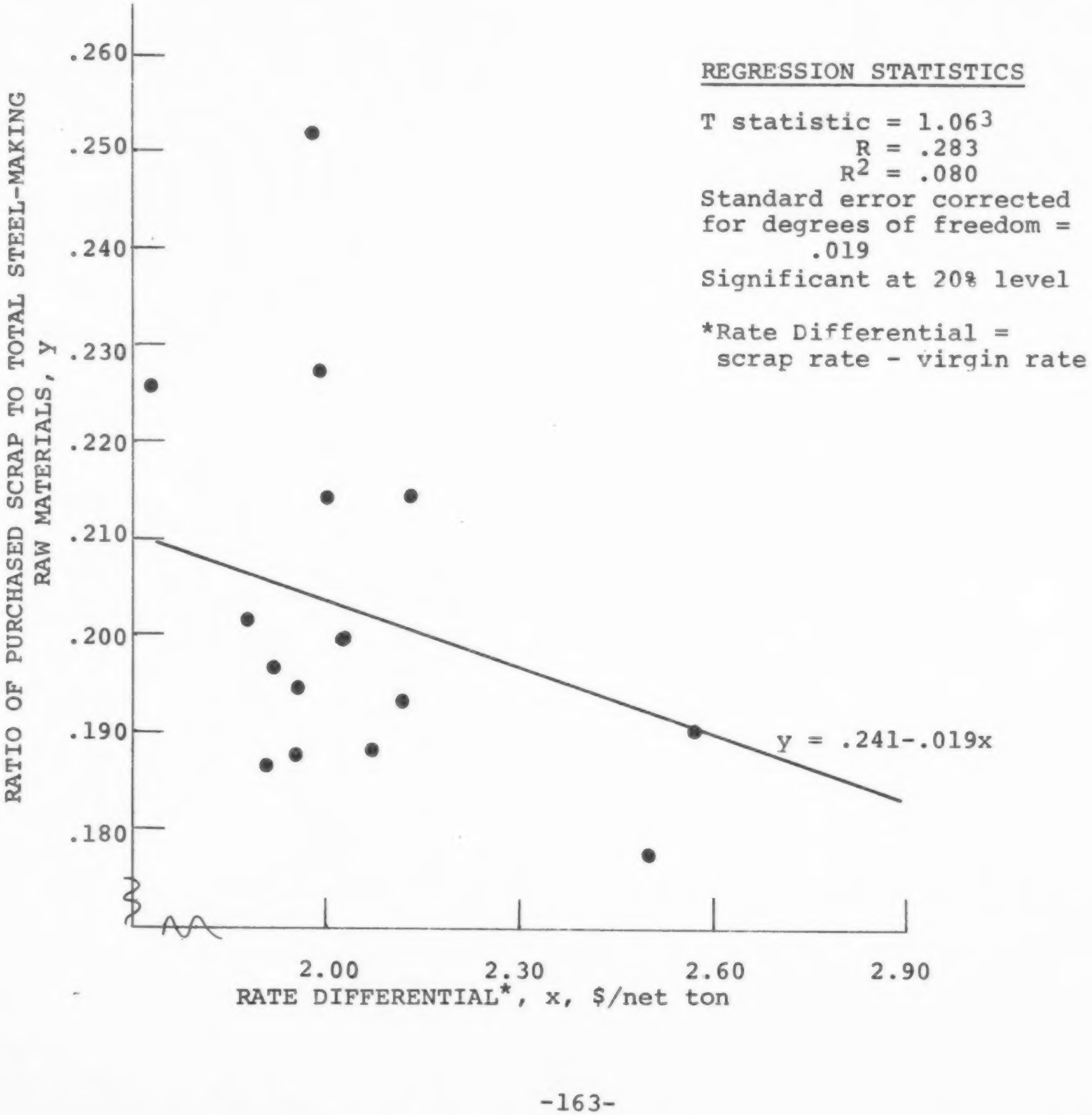


Figure 5-13. Proportion of Secondary Materials Consumed as a Function of Railroad Rate Differential - Chemically Adjusted on the Coal Basis

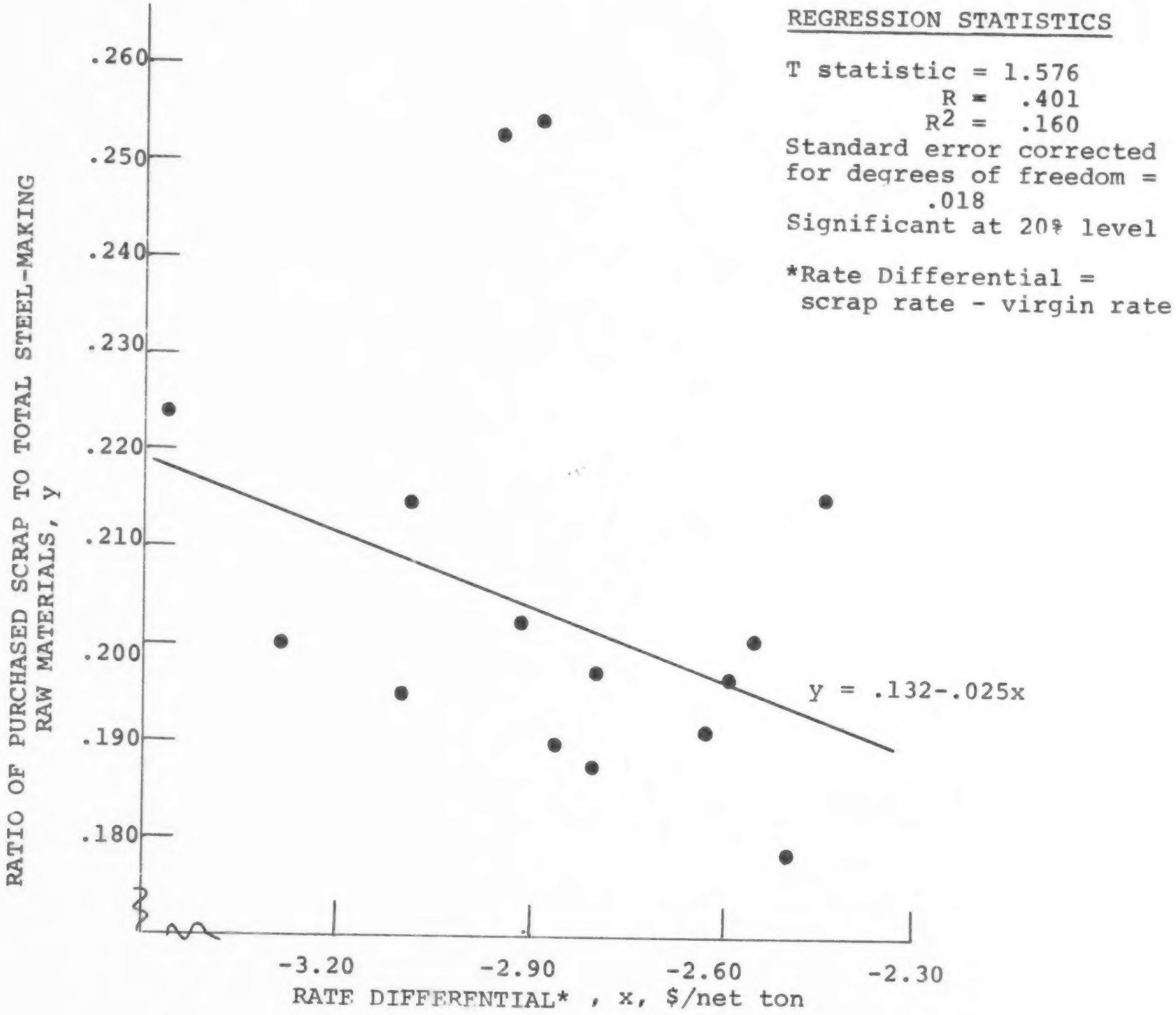
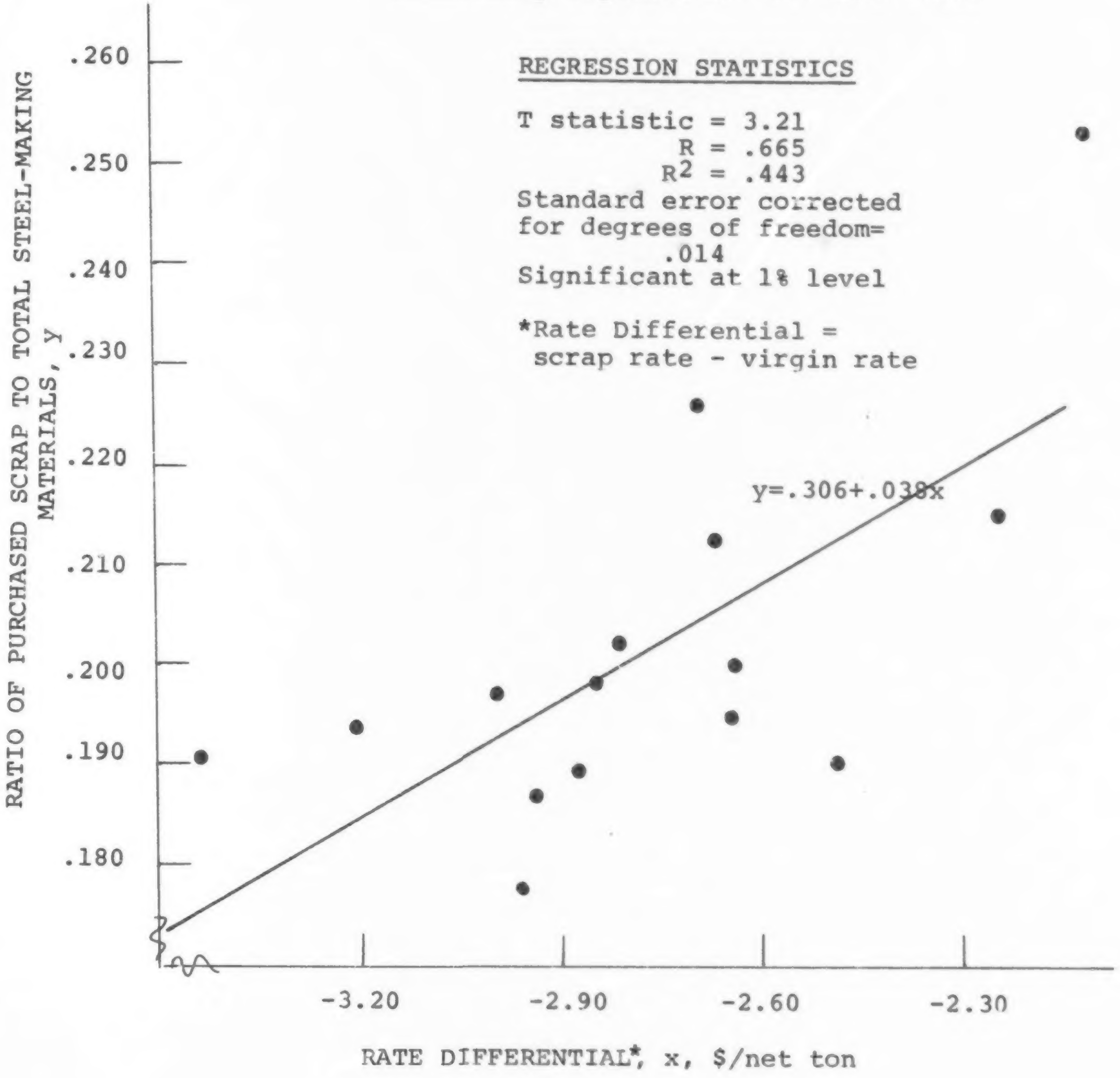


Figure 5-14. Proportion of Secondary Materials Consumed as a Function of Railroad Rate Differential - Chemically Adjusted on the Coke Basis



assertions of the regressions, at best, tenuous; the data scatter is considerable, and the trend lines may well show a neutral slope with the availability of more, less aggregated and complete, rate data.

In an attempt to obtain a better statistical fit to the data, a second independent variable was added to the regression. The new variable, time, was included to determine whether technological or temporal economic conditions were influencing the scrap ratio. Two regressions were made by adding the time variable to the direct rate differences between scrap and ore and the chemically-adjusted difference on the coal basis. These two regressions resulted in the following regression equations.

Independent variables: Chemically-adjusted rate difference and time

$$y = .3129 + .00387x_1 - .0279x_2$$

y = ratio of purchased scrap to all iron unit raw materials consumed
x_1= time; Std. error = .0013; $t = 2.92$
x_2= rate difference; Std. error = .020; $t = 1.36$

$R^2 = .403$; $R = .635$ (corrected for degrees of freedom)
Std.error of estimate = .0137
For $t = 2.92$, level of significance is 1%.
For $t = 1.36$, level of significance is 20%.

Independent variables: Rate difference between scrap and ore and time

$$y = .17318 + .00354x_1 - .028x_2$$

y = ratio of purchased scrap to all iron unit raw materials consumed
x_1= time; Std. error = .0010; $t = 3.44$
x_2= rate difference; Std. error = .0173; $t = 1.62$

$R^2 = .434$; $R = .659$ (corrected for degrees of freedom)
Std. error of estimate = .0133
For $t = 3.44$, level of significance is 1%.
For $t = 1.62$, level of significance is 20%.

It is evident in both equations that the variables used do not explain a majority of the influences that determine the use of secondary material. The R^2 in both equations indicate that less than 50% of the relationship is explained, hence the addition of other variables would be worthy of investigation in future research. The results of these equations do show a very slight increase in the ratio of purchased scrap to raw materials consumed over time. But the magnitude of this change is so slight that any change in scrap usage is nearly neutral with respect to transportation rate changes.

VI. CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

The conclusions of the study are stated in terms of the questions based on objectives of the study (see p. 9).

Question 1: What are the transportation costs for virgin and secondary raw materials in the steel and paper industries?

Estimates of 1970 average rates for railroad and common motor carriers of steel and paper-making raw materials are detailed in Tables 5-2, 5-8, 5-12 and 5-16 (pgs.116 123, 128, and 133). Railroad shipments, the most utilized mode for primary and secondary steel inputs and for virgin paper raw materials, had the following nationwide average rates for 1970.

Average Railroad Rates - 1970

Steel Raw Materials		Paper Raw Materials	
Iron Ore	$2.31/ton	Roundwood	$1.92/ton
Coal	3.43/ton	Wood chips or residue	2.58/ton
Limestone	2.47/ton	Wastepaper	8.01/ton
Scrap iron and steel	4.83/ton		

Rates of change for average railroad rates between 1969 and 1970 for paper and steel raw materials are shown below.

Steel Raw Materials		Paper Raw Materials	
Iron Ore	2.2%	Roundwood	2.7%
Coal	9.9%	Wood chips & residue	2.8%

Limestone	2.05%	Wastepaper	8.25%
Scrap iron and steel	10.3%		

In effect, secondary materials rates increased three to five times faster than those for virgin commodities. If these types of changes continue, we must conclude that scrap iron and steel as well as wastepaper will be more expensive to move than virgin commodities.

Common motor carriers generally charge more to move raw materials than do railroads. The following data summarizes the average rates for common motor carriers for 1970.

Average Motor Common Carrier Rates-
1970

Steel Raw Materials		Paper Raw Materials	
Iron Ore	$21.43/ton	Roundwood	$24.76/ton
Coal	2.23/ton	Wood chips and residue	2.44/ton
Limestone	NA	Wastepaper	9.68/ton
Scrap iron and steel	13.42/ton		

A sampling of inland water carrier rates for raw materials is summarized in Tables 5-10 (p.125) and 5-19 (p.145). The inland water carrier rate structure is generally lower than the railroad rate structure because of technological advances in barges and the lack of user charges on the inland waterways. In addition, inland water carriers operate under a more laissez-faire system which allows their rates to respond more freely to transportation market conditions.

Private and contract motor carriers provide a significant transportation mode only in the movement of wastepaper. Figures 5-1, 5-2, 5-3 and 5-4 (pgs.137,138 , 139 and 140) offer a sampling of carriage costs for moving wastepaper by this mode. From these figures emerges an average cost of $9.20 per ton of wastepaper. The popularity of owning or leasing trucks to ship wastepaper results from the availability of haul-back movements in the paper industry and the flexibility which the trucks offer the mills and wastepaper dealers. This type of trucker is the contract carrier, not the common carrier. This flexibility reduces transportation service costs, such as delivery delays, and thus makes it more desirable to ship wastepaper by private and contract carrier than by rail. High rates discourage the shipment of wastepaper by common motor carrier, an outgrowth of the common carriers' lack of desire to haul secondary commodities.

Tables 5-20 (p. 147) and 5-21 (p. 148) summarize the elements of service costs relating to the quality of transportation offered to shippers of virgin and secondary raw materials. Production delays from late deliveries, excess inventories from intermittent deliveries, special loading and unloading facilities and various other service factors all translate into additional costs for a shipper. Quantifying these types of costs goes beyond the scope of this study, but a subjective evaluation suggests that service costs do not change the polarity of transportation cost differentials resulting from the rate comparisons.

Question 2: What is the cost differential for shipping virgin and secondary materials in the paper and steel industries?

Cost differentials for shipping virgin and secondary paper and steel raw materials were calculated on a direct and chemically-adjusted basis for railroad and motor common carriers. The direct comparison was made between the average rates for either iron ore and scrap iron and steel, or roundwood and wastepaper, or wood chips and wastepaper. The chemically-adjusted cost differentials were calculated as the differences between equivalent amounts of virgin and secondary materials necessary to produce one ton of steel or one ton of corrugated medium. Because this calculation is believed to simulate the one used in the investment decision in the paper and steel industries, this seemed a viable way to determine the influence of transportation costs on the use of secondary materials.

Steel raw materials move almost exclusively by rail. Table 5-2 (p. 116) shows the 1970 direct average rate differences between iron ore and scrap, and Table 5-5 (p.119) gives the 1970 chemically-adjusted rate differences. On a nationwide basis for 1970, an average ton of iron ore moved for $2.52 less than a ton of scrap iron and steel (Table 5-2, p. 116). However, if coal were moved by rail to an integrated steel production facility, the chemically-adjusted average rate differences between virgin and secondary raw materials would show that the necessary amount of scrap moved at $2.51 less per ton of steel produced (illustrated in Table 5-5, p. 119).

Railroads haul the majority of virgin paper raw materials and about 40 percent of wastepaper as was seen in Table 4-11, p. 74. Most of the remaining wastepaper is shipped by private or contract carrier. Based on a direct intramodal average rate comparison of alternate virgin and secondary paper raw materials for 1970, roundwood moves at $6.09 per ton less than wastepaper, while wood chips and residues move at $5.43 per ton less than wastepaper (Table 5-12, p. 128). Comparing rail rates for chemically-equivalent amounts of virgin and secondary materials necessary to produce one ton of corrugated medium indicates that roundwood moves for $4.24 per ton of medium less than wastepaper and that wood chips cost slightly more to move than scrap. Since most new integrated (i.e. virgin material users) paperboard mills rely on wood chips, it appears that railroad transportation rates are essentially neutral with respect to rate differences between virgin and secondary materials. However, for those who use roundwood as the chief material fiber input, then the average rail rates are lower for the virgin commodity.

As has been mentioned, private and contract motor carriage have higher average transportation costs than do rail carriers. Despite this, they present a viable substitute for rail movement because of their flexibility and because they offer attractive haul-back opportunities. The comparison between railroad rates and contract and private motor carrier rates has been shown in Figures 5-1, 5-2, 5-3 and 5-4 (pgs.137, 138,139 and 140). If the higher private and contract motor carrier rates were substituted for average railroad rates in the chemically-adjusted comparison, the higher trucking rates would place roundwood and wood chips at a disadvantage against wastepaper. However, flexibility and the potential for back-hauls, might serve to reduce the differentials to those developed from the chemically-adjusted rail rate comparison. Thus, with trucks, as with railroads, roundwood would move at more attractive average rates compared to wastepaper while wood chips and wastepaper would move at about the same costs.

Inland water carriers offer a viable alternative mode for virgin paper raw materials but the necessity to make large shipments does not present a feasible situation for wastepaper. Direct comparisons of roundwood and wastepaper for equal distance movements by inland water carrier are shown in Table 5-19 (p.145). Again virgin materials move at more favorable rates than secondary sources. The sample suggests that, if water movement is an available alternative, and if the wastepaper collection system can supply the necessary size shipments, then transportation rates will favor the virgin raw materials.

Based on these chemically-adjusted comparisons as well as on the mode constraints and characteristics discussed in Chapters IV and V, it appears that scrap iron and steel move at a lower average rate than comparable virgin raw materials; and that roundwood moves at a lower rate than wastepaper, while wood chips move at a higher rate than wastepaper.

Question 3: What changes, if any, can be made to encourage the increased use of secondary materials in these industries?

This question cannot be fully answered from the scope of this study. More investigation into the significance of shipping costs as they relate to materials production should be done. In addition, the financial condition of the transportation industry, the potential supplies of secondary materials, the distribution capacity of the secondary materials industry and many other questions must be investigated before suggested changes could be developed.

In this light, the study and this question focus more on the need for change rather than the type of change.

In 1970, raw materials transportation costs were estimated to represent about 9.9 percent of production costs in integrated steel-making facilities and about 5.8 percent of production costs in electric furnace facilities for the production of one ton of steel. Raw materials transportation costs in the paper industry represented about 4.2 percent for integrated mills and 1.7 percent for non-integrated and board mills.[1]

Raw materials transportation costs stand at these relatively low levels because they are manageable costs which can be adjusted through managerial decisions. By locating integrated steel mills judiciously between ore reserves and coal and limestone deposits and by placing electric furnaces near scrap-generating population centers, it is possible to keep carriage costs low for raw materials.

This evidence points to two important dimensions in the investment decision. First, the location factor of placing an integrated facility between two relatively diverse sources of material (ore and coal) may force virgin material transportation costs above the cost of moving scrap to an electric furnace. The electric furnace, of course, can be located near a single source of raw material. In the future, management may well deem the electric furnace the more economically efficient steel-making facility.

Secondly, a new steel mill may often create enough traffic flow to provide its management with sufficient leverage to obtain rates at acceptable levels. With the ability to manage transportation charges through location, rate negotiation and other means, steel executives can work to reduce charges to minimum levels shown above, and, in effect, relegate transportation charges to secondary consideration in the investment decision.

In the paper industry, as well, raw materials transportation costs can also be managed so as to reduce them to a secondary place in the investment decision. By locating mills near population centers, the distances over which the raw materials must be transported can be reduced to a minimum. Judicious employment of back-hauls for non-integrated facilities and possible rate reductions from potentially increased volume provide additional aspects of management's ability to minimize transportation charges and reduce their influence on the investment decision.

Perhaps more important than actual transportation costs for both paper mills and electric furnaces is management's ability "to corner" or insure the secondary materials supply in the proposed location. By guaranteeing its supply, the mill can reduce much of the uncertainty associated with production costs.

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[1] See Table on page 151 and page 152 in Chapter V.

Although some transportation cost differentials have been shown to exist, their magnitude is not great enough to significantly change the use of secondary materials. Based on this analysis, then, it does not appear that a reduction in secondary materials transportation costs is needed to increase the use of scrap iron and steel or wastepaper.

RECOMMENDATIONS

This study has encouraged the point of view that transportation costs cannot be regarded in the abstract. These costs belong in the complex considerations that go into determining materials usage for products. The recommendation of this study is that more investigation will be needed if there is to be serious policy consideration of what cost factors, if any, should be adjusted to encourage more widespread use of secondary materials.

The recommendation is, therefore, to institute a broader-based analysis which would have as its goal the development of a computer model with the ability to simulate the multivariant nature of the investment process. Such a model would be able to detail with greater precision the influence of transportation cost differentials in an environment of the many variables which influence the investment decision. In addition, by modelling the investment decision on the dynamic system in which it operates, it would be possible to obtain a long-term perspective on the problem. In order to concentrate the resources of the study, it is recommended that the model be developed for a single industry such as the paper and paperboard industry.

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